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DEREGULATING THE ELECTRIC UTILITY INDUSTRY: FINANCIAL DISLOCATIONS AND IMPLICIT REGULATORY RENTS

Bennett W. Golub

March 1982

WP # 1392 - 83

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"Deregulating the Electric Utility Industry: Financial Dislocations and Implicit Regulatory Rents"

Bennett W. Golub

Energy and the American Economy Program
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ABSTRACT

The financial implications of deregulating the electric utility industry are explored in this paper. After reviewing the limited literature on deregulation, a general framework for computing the financial dislocations of customers, existing firms, and governmental tax revenues is developed. However, given the inherent complexity of this framework, no attempt was made to directly estimate the national financial impact of deregulation. The framework is suitable, however, for use at the utility or power pool level.

An alternative framework is then developed which lends itself to both order of magnitude estimates of the aggregate impact of deregulation and an approach to structuring the debate about the equity of the financial dislocations that deregulation will create. This approach involves calculating what one can term "implicit regulatory rents." Implicit regulatory rents are the present value of regulatory policies which cause deviations from outcomes consistent with long run competitive equilibrium. Using this approach, it was found that up to $196 billion dollars in present value might be transferred from customers to existing utilities through the loss of implicit regulatory rents. This figure is not, however, appropriate for use as a substitute for the financial dislocations referred to above. It permits two important observations. The first is that deregulation of the electric utility industry does have the potential to create huge financial gains and losses. The second, which may not be well recognized, is that any deregulation proposal must be concerned with the details of the prior regulatory regime since some very large sums of money, such as deferred taxes and outstanding long-term bonds, may mean very different things depending upon how the regulatory process defined them.

A financial simulation model is used to illustrate how implicit regulatory rents can be calculated at the level of an individual firm.

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DEREGULATING THE ELECTRIC UTILITY INDUSTRY: FINANCIAL DISLOCATIONS AND IMPLICIT REGULATORY RENTS

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1. Introduction

There exists a growing literature on deregulating the electric utility industry [1.1]. The electric utility industry is huge, with capital assets exceeding 220 billion dollars. Regulation of this industry is pervasive, covering rates, entry, and construction of facilities; consequently, deregulation might cause enormous financial dislocations. Deregulation, however, has been interpreted to mean very different things [1.2]. Therefore, before considering the impact of deregulation, the existing literature on deregulating the electric utility industry is reviewed.

Once the notion of what it means to deregulate the electric utilitiy industry is clarified, two issues involved in carrying out any program of deregulation are considered, namely, how to determine who wins or loses under deregulation, and what does a deregulation proposal mean given the perspective of the existing regulatory order. For example, deregulation may enable the firm to capture a sizable nominal capital gain on its assets which have been carried on the books at original cost. But conventional rate-of-return regulation computes the return on invested capital using a nominal rate of return. Therefore, under regulation, the investor should have already been compensated for the effects of inflation. Thus, consumers might argue that given previous regulation, deregulation would give existing firms an "unfair" windfall.

Similarly, a utility could argue that it should be compensated for the loss of its right to amortize an abandoned project through increased revenues, since these projects were initially approved by regulatory commissions. Indeed, given the cancelation of large nuclear projects, the loss of this source of regulatory protection might cause a number of existing utilities to default on their securities. The previous regulatory regime created an implicit contract between the investors and the consumers. All deregulation proposals must consider which, if any, of these implicit contracts should be honored after deregulation.

Deregulation opens up the possibility of changing the financial well-being of most individuals and firms in the United States, some rather dramatically. Restructuring financial assets and the regulations governing their cash flows leaves open the possibility of creating or destroying capitalized expectations, both of the investor and the consumer. This point is well articulated by Gray [1976].

> One of the greatest and most abiding evils of privileged monopoly is that it generates paper claim to income--or capitalized expectations. To the holders of such paper claims, however, it seems logical that government, having established the public utility by grant of privilege, should be responsible for making good any deficiency of income for the payment of interest and dividends. Failure to do so is construed as a gross betrayal of innocent investors. This interpretation seems further justified by the fact that government approves the issuance of these securities and, in addition, approves their acquisition by fiduciary institutions [p. 14].

What Gray does not consider is that regulation, once entrenched, also creates capitalized expectations, both for the consumer and the utility. Deregulation will destroy some or all of these capitalized expectations. This can cause large financial dislocations, both for the consumer and the investor.

The first task is to develop a method for measuring financial dislocations. These dislocations can only have one financial value--the sum of their expected cash flows, discounted at a rate appropriate to their financial risk. They can be computed for all the actors in the electricity market, the consumers, the security owners of the existing firms, and the government through changes in its tax receipts. For consumers, dislocations will be the capitalized change in consumer's surplus. For firms, dislocations will be measured as the change in value of previously regulated assets when they charge whatever price the market will bear for their output, as opposed to a price based on rate-of-return regulation. The change in government tax revenues can also be capitalized, assuming the existing structure of corporate and personal taxation is treated as fixed. In total, then, the computation of the financial dislocations caused by deregulation conceptually involves nothing more than a rather involved cash flow analysis. Unfortunately, actually completing these computations on a national scale is an enormous task, and I have not been able to develop any estimates using this direct approach.

The second task, and the main contribution of this paper, is to better understand what in particular happens when rate-of-return regulation is terminated midstream. Fortunately, this task is considerably more tractable. Table 1.1 is a composite balance sheet for the 203 largest electric utilities as of December 31, 1980. Notice that $1.394 billion dollars of utility plant was written off. On the liabilities side, $7.093 billion dollars of normalized ITC and $14.117

billion dollars of accumulated deferred income taxes sit on the utilities' balance sheet. $0.477 billion dollars of customer advances have also accumulated. These large sums of money have radically different meanings under regulation and deregulation. In measuring the impact of deregulation, some account must be made for the existence of these quantities, and it must be realized that they represent vestiges of a fairly intricate regulatory process. Therefore, the financial impact of deregulating the electric utility industry must be interpreted differently from seemingly similar impacts which arose from the deregulation of industries regulated under a different set of procedures.

For example, 105 billion dollars of utility debt is outstanding with market values considerably below their book value because of the generally higher level of inflation in the economy. But in most cases, the loss of the creditor is a gain to the debtor, and in the case of outstanding utility bonds, this amount is enormous. While the bonds are issued in the name of the various utilities, rate-of-return regulation effectively transfers most of the interest rate risk of those bonds to consumers since regulators use the historical embedded cost of capital in computing the allowed return on the utilities' rate base. This is very different from the situation which exists, say, for the bonds of a natural gas company subject to well-head price regulation (as opposed to gas *pipeline* companies subject rate-of-return regulation). Gas prices were determined without regard to the company's capital structure. The shareholders of the natural gas company bore the interest rate risk of

Figure 1.1

Privately Owned Classes A & B Electric Utilities
Composite Balance Sheet, as of December 31, 1980

(Millions of Dollars)

ASSETS AND OTHER DEBITS

UTILITY PLANT	
Total Electric Utility Plant	260,261
Less: Electric Utility Plant Accum. Depreciation	60,440
Net Electric Utility Plant, Less Nuclear Fuel	207,555
Net Nuclear Fuel	3,914
Net Other Plant	10,268
Net All Utility Plant	259,962
OTHER PROPERTY AND INVESTMENTS	
Total Other Property and Investments	6,528
CURRENT AND ACCRUED ASSETS	
Total Current and Accrued Assets	26,186
DEFERRED CREDITS	
Extraordinary Property Losses	1,395
Other deferred debits	4,115
Total Deferred Debits	5,510
TOTAL ASSETS AND OTHER DEBITS	259,962

LIABILITIES AND OTHER CREDITS

PROPRIETARY CAPITAL	
Common stock issued and other equity	79,044
Preferred stock issue	25,440
Total Proprietary Capital	104,483
LONG TERM DEBT	
Total Long Term Debt	105,257
CURRENT AND ACCRUED LIABILITIES	
Total Current and Accrued Liabilites	26,298
DEFERRED CREDITS	
Customer advances for construction	477
Accumulated deferred investment tax credits	7,094
Deferred gains from disposition of utility plant	3
Unamortized gain on reacquired debt	131
Accumulated deferred income taxes	14,117
Other deferred credits	2
Total Deferred Credits	23,592
OPERATING RESERVES	
Total Operating Reserves	332
TOTAL LIABILITIES AND OTHER CREDITS	259,962

Source: Statistics on Privately Owned Electric Utilities in the United States - 1980. U. S. Department of Energy.

the companies' bonds under regulation and there is no obvious reason why this should change under deregulation. This does not necessarily hold when firms subject to rate-of-return regulation are deregulated.

I propose an approach to understanding the deregulation of firms previously subject to rate-of-return regulation. Rate-of-return regulation can be decomposed into a number of distinct regulatory procedures. Each of those policies can be considered as causing an implicit change in the allocation of wealth among shareholders, bondholders, and customers. The present value of each of these policies, had the previous regulatory environment not been terminated by deregulation is defined to be an "implicit" regulatory rents, a deliberate change of the outcome of an unregulated market. Depending upon the deregulation proposal implemented, these implicit rents may or may not be destroyed, thereby changing the prior allocation. A deregulation proposal which does not recognize the existence of implicit regulatory rents and does not prescribe means by which the losers of those rents are compensated will be called "laissez faire" deregulation. By choosing to recognize some of these implicit rents, a logical basis for compensating losers can be constructed without any claim being made of confiscatory taxation.

Using aggregate national data, I have estimated that the implicit regulatory rents associated with deregulating the entire electric utility industry could be as large as $196 billion, going from consumers of electricity to existing producers. This figure, however, must be properly interpreted. It does not say that aggregate firm value will increase $196 billion at the expense of consumers. I have not been able to estimate that figure. However, if one knew the total financial dislocation and if it were very large, one could argue, from the perspective of the existing regulatory regime, that $196 billion of the financial dislocation could be attributed to the confiscation of implicit regulatory rents.

Actual financial dislocations must be estimated using models which equilibrate supply and demand in a deregulated world. Estimated implicit regulatory rents are based on incurred costs. The only occassion whereby implicit regulatory rents would equal the total financial dislocation would be if one could somehow assume that the industry was in long run competitive equilibrium and that a small firm which had monopoly power over a set of customers was subject to rate-of-return regulation. If this firm were deregulated and the regulatory-induced barriers to entry, such as its exclusive service territory, immediately disappeared, the present value of the firm would have to be the replacement cost of its assets. This follows from the definition of long run competitive equilibrium. In this world (which is far removed from today's) the change in the firm's value would have to consist of the sum of the present values of each regulatory policy which caused a deviation from long run competitive equilibrium outcome.

Implicit regulatory rents must be gleaned from the regulatory process by careful analysis. While the total regulatory rent destroyed by deregulation is "booty" (to use a term of Professor H.D.

Jacoby) to be divided by the political process, in the case of a firm previously subjected to rate-of-return regulation, a strong case might be made for reducing the financial dislocation by recognizing and preserving implicit regulatory rents. The residual dislocation after implicit regulatory rents are accounted for can be considered the distributional cost of obtaining increased economic efficiency.

As this paper was being prepared for review, the proposed settlement of the Government's anti-trust case against AT&T was announced. One of the key issues raised by the proposal involves the terms by which the deregulated part of AT&T will purchase assets from its regulated subsidiaries [Holsendolph, 1982]. AT&T would like to purchase these assets at book value. An effort is reported in Congress to require these assets to be purchased at their replacement cost. This is an example of an attempt to change the "laissez faire" outcome (book value transfers) by recognizing the implicit rent of customers to the appreciation on previously regulated assets.

The following additional questions, which are integral to the analysis of any deregulation proposal, are not addressed directly in this paper:

1) Whether such a policy is in the public interest. A policy of deregulation is assumed to have already been decided upon.

2) Whether or not the resulting market in bulk power would be competitive. No explicit model of price determination in a deregulated world is developed. The level of competition would be an important input to such a model.

3) Whether or not a decentralized electric power system will work as a complex engineering system requiring real time response to system dynamics. The system is assumed to "work" [see Golub, et.al., 1981 sec. IV].

4) Whether the regulated transmission network will behave as a social welfare maximizing benevolent monopolist.[1.3] The transmission network is assumed to behave tolerably well, i.e., it will transmit power at reasonable, if not optimal tariffs, and that its policies will not stifle entry or unduly distort plant siting decisions.

5) What the real resource cost of divestiture will be. The real resources required to implement deregulation are not estimated.

Moreover, the analysis assumes that the transition has already occurred and that any new regulated and deregulated entities to be formed out of the previously regulated vertically integrated monopolist already exist. This permits attention to be directed towards the long-run financial dislocations caused by deregulation. However, since annual cash flows will be computed and capitalized, some short-run effects will have to be estimated. Changes in the value of assets remaining under rate-of-return regulation are not explicitly considered because those assets should, in theory, retain the same value in terms of price to book ratio that they had before any assets were deregulated. This skirts an important issue which is beyond the scope of this paper, that is, the character of regulation when the regulatory process can control only a small part of the process by which prices are determined.

This paper is structured as follows: First, in section 2, the existing literature on deregulation is reviewed and critiqued. In section 3, a method for measuring the total financial impact of deregulation on the firm, the consumer, and the government is developed. In Section 4 the notion of implicit regulatory rents is further elaborated on. In section 5, the national magnitude of implicit regulatory rents are estimated using aggregate data and assuming all existing privately-owned electric utility assets are deregulated. To demonstrate how these rents can be extracted from the regulatory history of a firm, in section 6, a numerical example of applying the framework developed in section 4 is presented. The paper concludes with a discussion of the relevance of the analysis and a discussion of topics requiring future research.

2. Deregulating the Electric Utility Industry

Electric utility regulation arose early in the development of the electric power system. Its history is long and controversial [see Funingiello, 1973; Schmalensee, 1979]. The most widely held view is that regulation arose because of economies of scale, both in transmission and generation of electricity. As a "natural" monopoly, the efficient production of electric power required that only one firm provide the service. The resulting lack of competition required regulatory oversight to protect the public from excessively high rates.

Currently, their is a growing consensus that regulation is not working [Stelzer, 1981; Gordian, 1977; any issue of Public Utilities Fortnightly]. While there is room to debate the reasons for the problem and the appropriate culpability, this much is clear: the current utility companies are in poor financial condition and are having difficulties raising the huge quantities of capital required by the industry [Connor, 1980].

In response to this problem, a number of options for reform have been proposed. The regulatory process could be reformed to work better [Navarro, 1980; Navarro, Stauffer, and Peterson, 1981; Myers, Kolbe, and Tye, 1981]. Increased public ownership could reduce the need for an inherently faulty regulatory process [Shaker and Steffy, 1976 section B]. Larger regional private utilities could be formed with regional regulatory authorities [Gordian, 1977]. Lastly, given the growing evidence that the economies of scale in generation have been exhausted [Christensen and Greene, 1976; Stewart, 1979; Cowing and Smith, 1978; Huettner and Landon, 1978], a straightforward solution for bad regulation could be deregulation [Pace, 1981].

As discussed in this paper, deregulation will only refer to the bulk power, or generation, portion of the electric utility industry. These proposals can be divided up into three general approaches, incremental deregulation, total deregulation, and deregulation based on disintegration. Most credible discussions of deregulation limit themselves to generation. The transmission and distribution system have the normal common carrier property of economies of scale, reinforced by Ohm's law which dictates that power losses are inversely proportional to voltage squared.

Deregulating new generating capacity as it comes on line would be the least disruptive method [Alm, 1981; Hyman, 1981, pp. 25-28]. Under this approach, existing utility assets would remain subject to regulation, but new facilities could charge whatever the market would bear. Presumably, existing entry barriers, such as discriminatory control over transmission and distribution facilities and high concentration in the generating market, would have to be dealt with somehow. As has been noted [Alm, 1981; Golub, et al., 1981; Hyman, 1981], if the new generator was guaranteed the right to sell his power at its avoided cost to the main utility in the region, this would be equivalent to extending the provisions of PURPA [2.1] to permit unregulated facilities larger than the current statutory maximum size of eighty megawatts and to eliminate current restrictions on fuel usage and ownership. Hyman correctly points out that under such an arrangement, the financial contracts between distributors and deregulated generators would to a large degree reintegrate the separate entities.

Under such a scheme, there could be problems of strategic behavior on the part of the existing utility with some regulated and some deregulated assets. The regulated utility could increase its profits by following a strategy of increasing preventative maintenance on base-loaded regulated facilities during peak periods. This could direct excess profits to plants owned by its unregulated subsidiary. As Gillen [1981, p. 38] states, "an industry half regulated and half not may be the worst of both worlds."

An incremental deregulation approach which prohibited the regulated utility from having any direct ownership in deregulated facilties in its service territory would not be susceptible to this problem of perverse incentives. However, under any incremental approach, the existing utility assets would still remain under rate-of-return regulation. While the availability of capital for new construction would improve, this approach could be a double-edged sword towards the existing utilities. The requirement that today's utilities be able to raise new capital on the market is perhaps the best protection those firms have of adequate rate relief. Incremental deregulation would reduce the need for new capital, and with it, the market test of their regulatory environment. In its favor, incremental deregulation would not create the huge dislocations that more ambitious deregulation schemes would. No windfall profits or losses would arise under this scenario since no regulated property is freed from regulatory constraints. Moreover, little legal or organization change are required to implent it.

Deregulating all existing generation without altering today's vertically integrated firms has been hailed as both the salvation and the death sentence of the industry. Speaking before a House subcommittee, a utility executive declared:

> Total deregulation is something I wholeheartedly favor. With it, I will happily and easily improve the lot of the investor in our securities. Our powerplants, built at yesterday's lower construction costs, and financed largely with yesterday's cost of debt and preferred equity, will beat the pants off the prices charged by any newcomer that might venture into the field on a fully competitive basis. [2.2]

The alternative viewpoint, as described in [Pace, 1981, p. 12] is held by those who contend that central station generation is inherently uneconomical. As Pace correctly states, if this is true, "all bets are off" for the industry under total deregulation. A main problem with this form of deregulation is that potential entrants will be subjected to exclusionary behavior from the existing utility, given the high market share of the old utility in its former service territory.

This proposal could yield huge windfalls to the existing utility. While its neighbors might attempt to encroach on its service territory, under total deregulation, those utilities would not necessarily have access to the regions transmission facilities. New entrants would have the same problem, further exacerbated by the lack of any guaranteed customer base. Once in place, the entrant would be selling power in a market dominated by the generating facilities of the old regulated monopolist.

The most comprehensive approach to deregulation involves divesting generating assets from the regulated utilities and permitting their new owners to compete for the right to sell power to the still regulated transmission and distribution (T&D) network. This proposal aims at eliminating the two problems cited above with total deregulation. First, by disintegrating the T&D from generation, access by all power producers is likely to be improved. Secondly, by divesting the generating facilities to multiple owners, the near monopolistic power of the existing ownership structure would be reduced, increasing the competitive nature of the market.

Under one group of proposals [Cohen, 1979; Landon and Huettner,1976], competition would be based on the terms offered in long-term supply contracts, whereas under another [Bohn, Caramanis, and Schweppe, 1981; Golub, et. al.,1981], competition would occur based on a real-time, auction-like, spot market in electrical energy. However, under either of these approaches to deregulation and divestiture, regulation would only be continued on the T&D because of its common carrier properties. The exact relationship of the transmission system to the distribution system has not been discussed in great detail in the literature, probably because it is not that important an issue. According to Pace's "Conclusion Number 6" which he gleaned from the existing literature on deregulation (although not his conclusion),

> "The electric utility industry should be vertically disintegrated. Specifically, the transmission grid in each area should be owned by a separate pervasively regulated private common carrier or it should be publicly owned. The distribution system in each community or in each small group of communities should be separately owned. Finally, individual generating plants should be owned by competing firms having no interest in transmission or distribution properties." [p. 6]

Both of the deregulation and divestiture proposals have problems. The long-term contracts approach has been criticized as requiring too much out of the contracting process [Pace, 1981b]. Bilateral contracts also make it difficult to exploit an optimal mix of generating technologies, reducing the benefits currently derived from least-cost central dispatch [Golub, et.al., 1981]. The spot pricing approach suffers because of the T&D's loss of direct control over the independent generators. This might make the electrical grid function unreliably. The suggested technique of pricing numerous attributes of each independent generator's behavior would result in a propagation of markets. With a finite number of participants, these various markets for "commodities" such as reactive power, dynamic response, and load following, could become thin, especially when they are spatially seperated. Therefore, there is reason to question whether the whole system would behave optimally.

All the deregulation schemes raise many unanswered questions, as was alluded to in section 1. In this paper, the dislocations resulting from deregulating previously regulated assets are studied. Since no such dislocations arise from a policy of incremental deregulation, from herein, deregulation will refer to schemes such as total deregulation,

deregulation and divestiture, or variations on those approaches which involve deregulating previously regulated assets. This is not to dismiss the incremental approach. Its greatest attraction is that it does not lead to the problems which will be discussed in the rest of this paper.

3. The Financial Dislocations Caused by Deregulation

Assuming that the expected future price path over time in the deregulated bulk power market can be estimated, the financial impact of deregulation on the four main groups affected, bondholders, stockholders, customers, and the government's tax revenues, can be calculated. A method for performing this calculation given a price path will be discussed in this paper, not the derivation of the future price path itself. Later on in this section, some of the issues associated with the estimation of price paths will briefly be discussed. The estimation of future price paths, on a national level, is an enormous task, even if perfect competition is assumed. On a firm or power pool level, however, the task is reasonable.

Deregulation will also have an impact on electric generation equipment suppliers. Presumably, competitive pressures on generating firms would increase their aggressiveness in dealings with suppliers. Suppliers might also integrate into the generating business themselves. This would add some potentially powerful new competitors and open the possibility for some gamesmanship by these equipment suppliers as they developed strategies for pricing equipment to other generating firms. However, a complete discussion of this issue is beyond the scope of this paper.

The impact of deregulation is illustrated in Figure 3.1. The deregulated market will equilibrate at a new price and quantity, yielding a new total cost to consumers and a new earnings before interest and taxes (EBIT) to the firm. For purposes of analysis, the firm can be treated as an entity which receives EBIT from operations and pays it out as tax payments to the government, dividends to its shareholders, and interest payments to its bondholders. Retained earnings can be treated as the automatic reinvestment of dividends. Because the incidence of tax on interest payments and dividends is not certain, they are indicated by dotted lines.

Changes in cash flows can be capitalized into a net present value that measure the dislocation which has occurred. Dislocations can also be measured directly if a competitive market in utility assets exists and deregulation changes the ownership of the assets in any way. To analyze the impact of deregulation, all of these dislocations will be isolated for each of the actors in Figure 3.1.

3.1 Impact on the Firm

3.1.1 The Value of the Firm After Deregulation

The unregulated generating firm will be analyzed in an environment where the firm is paid the real-time spot price for its output. Whether or not divestiture actually occurs is irrelevant, although the number of independent generating firms will affect the level of competition in the market. This in turn may dictate how the future price path is determined. If a long-term contract specifying prices was in force, the analysis would be simpler, since all that would be required would be to analyze the present value of the firm's contract.

Paying the generator the spot price for his output is not that different from the way economy interchange is conducted today, except that in the unregulated "electricity market," the joint system lambda of the buying and selling utility would be the spot price. With economy interchange as it is generally practiced, firms often split the difference between the two system lambdas. This does not necessarily always equal the joint system lambda. Aside from this minor difference, if firms are paid the spot price, and that spot price is determined competitvely, then a deregulated "electricity market" with spot pricing will replicate the outcome of a centrally dispatched utility system minimizing total costs.

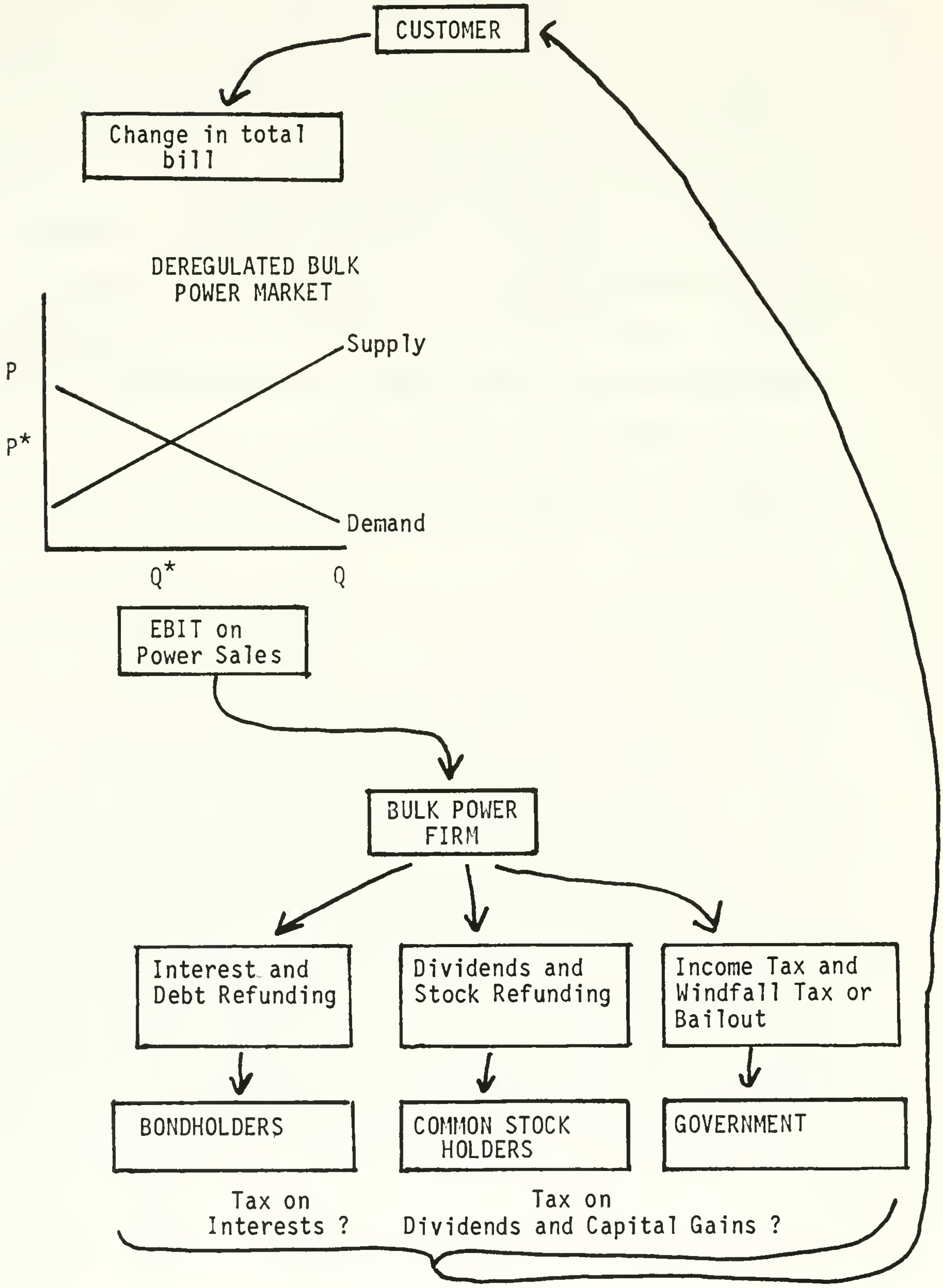
Assuming that the deregulated generator receives the full spot price [3.1] of electricity, the following equation defines what the market value of plant K must be in an efficient, competitive unregulated bulk power market. The discount rate r^* is an adjusted required rate of return which takes account of the interaction between the tax effects of the financial structure of the firm and its investment policy. It will be discussed in section 3.1.2.

$$(3.1) \qquad PV_K = \sum_{i=1}^{LIFE^K} \sum_{j=1}^{8760} \frac{[\ (P_{ij} - MC^K)[Q^K_{ij}(P_{ij})] - FOM^K]\ (1 - \tau)}{(1 + r^*)^1}$$

$$+ \sum_{i=1}^{TXLIFE} \frac{\tau * TAXDEP}{(1 + r_{TS}})$$

$$Q^K_{MAX} \text{ .GE. } Q^K_{ij} \text{ .GE. } 0,$$

Table 3.1
Financial Impact of Deregulation


CUSTOMER
Change in total bill
DEREGULATED BULK POWER MARKET
P
P*
Supply
Demand
Q*
Q
EBIT on Power Sales
BULK POWER FIRM
Interest and Debt Refunding
Dividends and Stock Refunding
Income Tax and Windfall Tax or Bailout
BONDHOLDERS
COMMON STOCK HOLDERS
GOVERNMENT
Tax on Interests ?
Tax on Dividends and Capital Gains ?

where

r^* = the adjusted cost of capital of the firm;

r_{TS} = the appropriate discount rate for tax shields;

$TAXDEP_i$ = the tax depreciation allowance in year i;

PV_K = present value of plant K;

$LIFE^K$ = remaining lifetime of plant K;

P_{if} = market price in year i hour j;

MC^K = marginal cost of plant K;

$Q^K_{ij}(P_{ij})$ = quantity demanded, in kwh, produced by plant K in year i hour j;

Q^K_{MAX} = maximum output of plant K;
FOM_i = fixed operating and maintenance expense for plant K;
8760 = number of hours in 365-day year.

This must be the market value of the asset in a deregulated world, because those are the only cash flows available to its owner. The regulated market value, original construction cost, or even the plant's replacement cost are not relevant, although the plant's original cost will be relevant for tax matters. The discrepancy between market value and book value is a capital gain or a capital loss. For example, an old oil-fired plant confronted with an abundant amount of competing coal-fired capacity and a relatively flat system load duration curve might only be worth its scrap value--the unit just might not be able to compete. Under regulation it had a positive market value, because its owner was allowed a return on the non-depreciated original cost of his investment. Under competition, the owner would face a large capital loss, because the unit could not sell its power profitably. Similarly, the owner of completed nuclear plant in a region where oil is burned on the margin might suddenly find that under deregulation the plant's capital value increased dramatically. Summing the market value of all the generating plants of a utility, the market value of a currently regulated utility's generating plant under deregulation can be estimated.

Current utility planning methods permit calculations of price paths under competitive assumptions to be done without much difficulty. Caramanis [1981] has developed an algorithm which is particularly well suited to this task and also "closes the loop" between investment planning, electricity pricing, demand elasticity, and the optimal expansion plan. Instead of today's practice whereby a utility computes an optimal capacity plan by taking note of what capital stock it has in place, each plant's marginal costs and expected forced outage rates, planning in a competitive environment would requiring modelling each competing firm in the utility's region as a supplier. The utility would look for potential "holes" in the market, for example, a profit opportunity existing for a period of a few years before a competitor's large base loaded facility was completed. During this period, the utility could expect to make substantial returns by installing and running some less capital intensive units.

The assumption of competition may not be viable. This makes the estimation of price paths more complicated. [3.2]. The planning process will thus be hindered by oligopolistic gaming. Fortunately, a priori, there is some reason to believe that a competitive bulk power market structure could develop [Weiss, 1975]. All that can be said with any confidence is that prices will have system lambda as their lower bound. To the degree that oligopoly exists, a positive markup over costs may exist.[3.3]

Given the value of the firm after deregulation, the impact of deregulation is simply the change in the value of the firm. The value of the regulated firm can be estimated by discounting its expected cash flows generated by a regulatory cash flow model. However, the most preferable method would be to simply read the Wall Street Journal and find the current price of its securities. Aside from the effect on security prices of anticipated deregulation, the market price will be the discounted expected cash flows under regulation.

3.1.2 Discounting the Cash Flows of a Deregulated Firm

The appropriate value of r^* in equation (3.1) was not previously discussed. Without a discount rate, the value of the assets cannot be determined. The determination of an appropriate r^*, however, cannot be discussed without some reference to the securities issued against the assets.

Given the ability to estimate the future cash flows of the asset, it is possible to analyze them to reveal an asset beta [3.4] for an unregulated bulk supplier of electricity. Cash flows will be a function of demand, and the covariance of electricity demand and overall economic activity can be estimated. This permits an asset beta to be estimated. This asset beta must then be used to find an appropriate all equity discount rate using the capital asset pricing model.

Given the volatility of the expected cash flows, the optimal level of debt for the firm must be ascertained. The optimal level of debt equates, on the margin, the present value of bankruptcy costs with the present value of the tax shield of the debt. Given a level of debt, the present value of the firm can be computed. [3.5]

The adjusted present value method of Myers [1974] provides the most precise way of capitalizing cash flows, taking the side effects of debt financing into account. However, the use of recursive methods is somewhat cumbersome. This difficulty is eliminated by the formulation of an adjusted discount rate [Myers, 1981]. The desirability of using an adjusted discount rate in this application is reduced, unfortunately, by the need to determine an unlevered equity discount rate and a risk-free rate of return. For better or worse, public utility regulation is wedded to the notion of a weighted average cost of capital. Debt rates and levered equity rates are in the vernacular of ratemaking. All available experience and data are in terms of actual, levered betas. That being the case, the cash flows of the deregulated firm might also be capitalized using an after-tax weighted cost of capital. This may be rationalized by thinking of the firm as being owned by a large, homogeneous holding company which maintains a constant capital structure in terms of market values.

The cost of capital to the deregulated firm will not, in general, equal the cost of capital to the regulated firm. Most likely, the cost of capital to the deregulated firm will be higher than the marginal cost of capital of the regulated firm, since regulation provides the firm with protection from competition. Regulation transfers much of the financial risk of the utility assets to the consumer. Deregulation will shift more of these risks to the firm.

Performing this analysis for a single unified utility system is a substantial, although feasible task. Currently, an effort is being made to perform this type of analysis for selected utility systems and will be the topic of future papers.

3.2 Impact on the Customer

The same model which estimates the revenues of the firm under deregulation provides an estimate of the total bill paid by consumers. Similarly, the model which estimated the cash flows of the regulated firm can estimate the revenues received by the firm under continued regulation. The revenues of the firm are the bills paid by consumers. Taking the difference between the capitalization of these two streams of cash flows, the financial impact on the consumer can be measured. This is the method most commonly used in practice to measure the impact of any plan undertaken by a regulated firm. Deregulation could thus be measured as just another plan. Thus, the criticisms of this approach are equally applicable to the general practice of revenue requirements analysis as is practiced by the industry today.

This method does not measure economic welfare. It will tend to overstate the impact of deregulation because consumers will be able to substitute to or from electricity to partially offset the effect of a price change. While the demand for electricity is not highly elastic, it clearly is not as inelastic as was once believed.

Fortunately, it is not too difficult to develop a welfare measure given the data and models already available. Regulatory financial models and the underlying regulatory process determine allowed revenues. Given the level of revenues allowed, utilities submit a rate schedule which they believe will permit them to achieve it. For the utility to do this correctly, the underlying demand curves of the customers must be known to some extent. While many utilities may not actually use explicit demand curves to develop rate schedules subject to a revenue constraint, this sort of analysis is technologically feasible. Using these demand relationships, a rate structure model can be constructed. From this model, the prices and expected levels of sales can be estimated.

The expected prices and quantities under deregulated prices are obtained directly from the model which computed expected EBIT. Combining this information with the prices and quantities under regulation and the parameters of the demand curves, a measure of the change in consumer surplus can be computed.

$$(3.2)\quad \Delta CS_i = \int_0^\infty \int_{p(t)}^{\lambda(t)} Q_i(P)\, e^{-r_i * t} \, dP \, dt$$

where

ΔCS_i = change in consumer surplus of user i;
$\lambda(t)$ = price under deregulation at time t;
$p(t)$ = price under regulation at time t;
$Q_i(P)$ = inverse demand curve of user i;
r_i = discount rate of user i;
t = time.

The use of a continuous time discounting function makes the notation easier. In practice, discrete time intervals would be used, since instead of price functions, time series of price data would be available.

Aggregation of electricity consumers causes two problems. Economic welfare is not equal to Marshallian consumer's surplus in general, although Willig [1976] shows that the error associated with this approximation is often small. If desired, for simple demand specifications, following Hausman [1981], an exact measure of the change in welfare can be computed. This approach might be helpful with electricity since it is consumed over the entire spectrum of incomes. This is important because the resulting changes in wealth will not zero sum transactions. The welfare loss to consumers may very well be greater than the increase in the wealth of the producers. Moreover, since r_i will be very inversely correlated with income, disaggregation by income class will be necessary in any event.

$$(3.3)\quad \Delta W = \int_{-\infty}^{\infty} \int_0^{\infty} \int_{p(t)}^{\lambda(t)} Q(P,y) * e^{-r(y)*t} * I(y)\, dP\, dy\, dt$$

where

ΔW = change in welfare;
$Q(P,y)$ = demand function expanded to include the income effect;
$I(y)$ = income class distribution;
$r(y)$ = discount rate as a function of income.

Obviously, as the precision of the estimate improve, the data requirements increase. However, the above equation is within the realm of tractable applied, empirical work.

The second aggregation problem is due to electricity being both a retail and wholesale good. Residential customers pay their bills with after-tax dollars. Commercial and industrial customers deduct the cost of electricity against taxable income. Thus, a consumer would discount his stream of future electricity bills at an after-tax rate while the commercial and industrial customers would use a before-tax rate. The corporate tax rate can be treated as constant in the relevant range of most firms, but the marginal tax rates of individuals varies significantly. To do this right, a distribution of marginal tax rates would be required. If the analysis was being performed on an aggregate basis, a weighted average marginal tax rate would be sufficient. Thus, equation (3.3) must be modified to include terms for commercial and industrial consumers of electricity. For non-residential consumers, no account of income effects is needed.

3.3 Impact of Tax Revenues

The tax liability of the deregulated firm is a function of its stream of earnings before interest and taxes (EBIT). The tax liability can be approximated as the following fraction of EBIT of the firm which is derived in appendix 1.

$$(3.4) \qquad \text{TAXFRAC} = \frac{\frac{\tau}{(1-\tau)}\ \text{EQSHAR} * r^{D}}{(1 - \text{EQSHAR}) * i^{D} + \frac{1}{(1-\tau)} * \text{EQSHAR}^{D} * r}$$

$$(3.5) \qquad \text{GOVWLTH}^{D} = \text{TAXFRAC} * \sum_{i=1}^{\infty} \frac{\text{EBIT}_t}{(1 + r^{D})^{i}} - \tau \sum_{i=1}^{\infty} \frac{\text{TAXDEP}_t}{(1 + i^{D})^{i}}$$

where

TAXFRAC = share of EBIT due for tax liabilities in year t;
GOVWLTH = governmental wealth under deregulation;
τ = federal income tax rate;
EQSHAR = actual proportion of equity in capital structure;
r^D = required rate of return on deregulated equity;
i^D = average required rate of return on deregulated debt.

This tax liability must be reduced by the tax shields arising from the tax depreciation allowances, if any, that the firm is entitled to.

Since the stream of tax liabilities, net of tax shields from depreciation, are directly correlated with the firm's equity, they should be discounted at the deregulated equity rate. Since the tax shields from depreciation are nearly certain, they should be discounted at a lower rate. This gives an estimate of the "wealth" of the government under deregulation.

Similarly, the regulatory cash flow model that estimates cash flows to equity and total electric bill to consumers can also estimate the expected cash tax payments to the government. These payments, discounted at the regulated equity required rate, are the government's "wealth" under regulation. If cash tax payments, as opposed to deferred taxes, are proportional to earnings, the equity rate is about the appropriate discount rate. Differencing the present value of the tax liability under deregulation and regulation, an estimate of the impact of deregulation or the government can be derived.

In practice, the vagaries of the tax code ensure that the value computed in (3.5) is an extreme upper bound estimate. Part of the gains probably would be treated as capital gains, which are taxed at a lower rate. Furthermore, each firm would exploit all the tax shelters available to it to minimize the actual cash taxes the government receives. Neither of these effects are accounted for in this simple model of the tax system. If desired, a more complete model could be constructed. For purposes of exploratory policy analysis, the above approach should suffice.

4. IMPLICIT REGULATORY RENTS

In Section 3, a method for measuring the financial impact of "laissez faire" deregulation was developed. Given an estimate of these dislocations, the trade-off between the dislocations and the (presumed) increase in efficiency that deregulation brings must be weighed. If this outcome is not desirable by whatever criteria it chosen by public policy, the "laissez faire" deregulation proposal must be modified to reduce these dislocations while still preserving the efficiency gain. As such, the future debates over the deregulation of electricity will be similar to the acrimonious debates over the deregulation of domestic oil prices and those currently being waged over the deregulation of well-head natural gas prices. In this section, the specific details of rate-of-return regulation are examined to reveal both a simplified method of assessing the long run impacts of deregulation and an approach to structuring the debate over what constitutes a "fair" deregulation proposal.

Throughout this section, reference will be made to ideal or perfect regulation. These terms refer to a form of economic regulation which leads investors to expect to earn just the rental cost of capital, no more or less. With this view, rate of return regulation is a mechanism to replicate long run competitive equilibrium [see Myers, 1972].

Perform the following mental experiment. Imagine that investors put up $UP to build a utility plant that does not depreciate over time. Suppose that under rate of return regulation they would expect to receive in perpetuity an after-tax cash flow, $ATCF^R$. Suppose that if the firm were deregulated, it would receive an after-tax cash flow, $ATCF^D$. The time series of $ATCF^D$ might come from the sort of model referred to in section 3. Let r^R and r^D be the required rate of return on capital under regulation and deregulation, respectively, and assume they do not change over time.

Under ideal rate of return regulation,

$$(4.1) \quad ATCF^R = r^R * UP.$$

At all times the discounted value of the firm's after-tax cash flows equals the value of the firm's capital:

$$(4.2) \; PV^R(UP) = \sum_{i=1}^{\infty} \frac{ATCF^R}{(1+r^R)^i} = \frac{AFCF^R}{r^R} = \frac{r^R * UP}{r^R} = UP.$$

The present value of the utility plant under ideal regulation thus always equals the cost of the plant, preserving the investor's capital.

Using equation (3.1), the present value of the plant under deregulation can be computed. The impact of deregulation on the firm is thus

$$(4.3) \quad PV^D(UP) - PV^R(UP) = \pi_{LF}$$

where π_{LF} represents the profit or financial dislocation caused by "laissez faire" deregulation. These regulatory rents are the capitalized returns above the cost of the facilities in place. Depending on the shape of the load duration curve and the mix of competing generating plants, they can be positive or negative. The existence of non-zero profits when the utility is deregulated is a measure of disequilibrium introduced by regulation, particularly the suboptimality of the regulated utilities' mix of generating technologies, or the change in the replacement costs of the assets.

π_{LF} is directly comparable to the windfall gains which arise under oil or natural gas deregulation. An owner of a regulated well sees a discrepency between the market price of the well's output and the price he is allowed to receive. Capitalizing this differential, the well owner can calculate the cost to him of regulation. In contrast, the owner of the rate-of-return regulated facility has a more complicated analysis to perform, since he sees deferred liabilities on his balance sheet, positive returns on otherwise useless abandonments.

Lest the reader be tempted to dismiss the detailed discussion of regulatory procedures which follow as picayune details, consider the following issue which is currently being debated by regulatory commissions. In 1978, the corporate income tax was reduced from 48% to 46%. Consumer intervenors have therefore argued that previously accumulated deferred taxes from accelerated depreciation were now too high, since the future taxes that they were designed to pay had thus been reduced. Therefore, they proposed, and in some cases, have won, an expedited amortization of the "surplus" deferred taxes [see Radford, 1981]. Customer advocates really do believe that deferred tax balances are held in escrow for them. No one should expect anyone to be fooled or to forget about the billions of dollars currently deferred by today's utilities. Moreover, there are numerous other aspects of regulatory policy that will be subjected to similar scrutiny.

4.1 Sources of Implicit Regulatory Rents

As actually practiced, rate of return regulation involves much more than simply applying a rate of return to paid in capital. The additional procedures can be divided into three general categories, transfers of financial risk onto the consumer, revenue reallocations designed to achieve intertemporal equity, and systematic regulatory errors, either caused by defective rate making formulae, or by the politicization of the regulatory process. Each of these procedures changes the financial well-being of the participants in the energy marketplace. Deregulation, unless otherwise specified by statute, will alter the financial consequence (intended and unintended) of these procedures. In this section, these procedures will be considered. The potential wealth transfer between consumers and the firm will provide the primary focus, although the potential for intra-firm dislocations is considered.

Rate of return regulation transfers part of the financial risk of the electric power industry away from the firm. These risks can be from financial markets, predetermined price long-term contracts, changes in technology, changing patterns of demand, or changing asset prices. A priori, the customer can win or lose on each of these gambles. Suppose the replacement cost of the utility plant changes to UP^*. The customers have effectively won or lost $UP^* - UP$. Suppose the utility enters into a long term fixed price contract.

Since the regulatory process aims to keep the after-tax cash flow of the firm per unit of invested capital constant, the consumer is essentially in the position of a commodity speculator. At a given point in time, some of a priori fair bets have had their uncertainty resolved. Thus, upon deregulation, the firm is left with the a posteriori realization of the gamble. Therefore, in addition to whatever profits may be intrinsic the structure of the marketplace, the firm is also left with the results of previous wagers.

In a number of ways, regulation attempts to achieve intertemporal equity among consumers. The tax saving from accelerated depreciation and investment tax credits (ITC) are often normalized to transfer some of these benefits to future customers. When a large facility is abandoned by the firm and, in the opinion of the regulatory commission, the initial decision to build the plant was prudent and, under present circumstances the decision to abandon the plant is prudent, the firm is often allowed to amortize the cost of the plant over a set number of years, usually five or ten. If a firm were deregulated before previously allocated funds for redistribution were disbursed, the present value of future rate reductions would be lost by the consumer. In the case of deferred taxes and ITC, the firm would effectively expropriate these deferred liabilities, and the government's tax revenues would be higher than otherwise expected because the expected revenue reduction, with its corresponding negative effect on taxable income, never occurred. In the case of abandoned property, the present value of the amortization of these costs would be lost by a firm if it were deregulated, assuming that the amount of costs allowed to be amortized was net of any salvage value.

Rents may also arise from the sudden discontinuance of errors in the regulatory process. I call these regulatory environments "inadmissable", because they do not have a net present value of zero, when obstensably they claim to. This is a strong term, but these policies are inconsistent with the notion of regulation as a substitute for the outcome arising in long term competitive equilibrium. While regulators may be able to live with these errors, capital markets are not as tolerant; the errors will be reflected in the value of the firm. The capitalization of these systematic errors can be characterized as an implicit regulatory rent.

Since procedures vary from jurisdiction to jurisdiction and change all the time, an exhaustive list of errors would be hard to compile. The use of a historic test year when there is positive expected inflation and no other mechanism to adjust for this known increase in costs is one example. Prohibiting the compounding of the allowance for funds used during construction (AFDC), without including the accumulated AFDC in the rate base is another. In another case, an apparently well intentioned commission incorrectly computed an allowance for taxes, resulting in an excess return on normalized investment tax credits [Public Utilities Fortnightly, 1980]. So long as these errors are expected to persist, they will be capitalized by the market.

It would be naive to attribute all inadmissable regulatory procedures to an ignorance of accounting and financial principles. The political environment surrounding the regulatory process leads to positive and negative biases towards corporate profitability. In an era of increasing costs, the commission may be under considerable pressure to keep rates low, regardless of the impact on the owners of the firm [Joskow, 1976]. The various characteristics of regulatory commissions and their effect on earned rates of return has been analyzed [Navarro, 1980; Hagerman and Ratchford, 1978]. Navarro bases his analysis on investment bankers ratings of regulatory commissions which is related to the actual cost of capital that utilities in those jurisdictions will have to pay. Hagerman and Rachford analyze the rate of return explicitly allowed (although not necessarily earned) by a cross section of regulatory commissions. While the two studies are not in complete agreement as to the effect of various proxies for the regulatory commissions' political independence, both found the individual commissioners' term of office to be statistically significant. Longer terms of office were found to result in higher ratings by investment bankers as well as higher allowed rates of return in regulatory proceedings.

Perhaps the key variable is the allowed rate of return on equity. While commissions can tinker indirectly with the regulatory procedures to effect allowed revenues, the return on equity leads most directly to profit. For expositional simplicity, the effects of procedural errors can be seperated and lumped under the category of inadmissability, while the errors in the regulatory procedure which arise from political intervention can be lumped with distortions in the allowed rate of return on equity. It must be acknowledged that estimating the cost of capital, even with the best of intentions, is tricky, and legitimate errors could occur.

Combining all of the implicit rents, equation 4.3 can now be rewritten in terms of a modified rent to the firm, π_M.

(4.4a) $\pi_M = \pi_{LF} - \text{IMPLICIT}$

where

IMPLICIT = recognized implicit regulatory rents.

While the total windfall to the firm is uniquely determined, exactly what is chosen to be recognized as an implicit regulatory rent is somewhat arbitrary. In section 4.2, rate-of-return regulation is broken down into a number of components. A method for computing the value of each component is discussed. It must be noted, though, that any number of alternate decompositions would be logically consistent. Indeed, one of the key subjective elements of the theory of implicit regulatory rents is the determination of exactly which regulatory procedures should be considered as deliberate, prior adjustments to free-market outcomes, and therefore, should provide the basis for compensation when regulation is removed.

Equation (4.4a) does not account for the fact that the firm is owned by both stockholders and bondholders. In general, they make out very differently under deregulation. This can be expressed as

$$(4.4.b)\ [PV^D(EQ) - PV^R(EQ)] = \pi_{LF} - \text{IMPLICIT} - [PV^D(D) - PV^R(D)]$$

since the equity receives the residual value of the firm. These intra-firm regulatory rents are discussed in 4.3.

4.2 Customer-Firm Regulatory Rents

To determine the amount of rent, either an amount of effective asset or liability transfer must be measured or incremental cash flows must be capitalized and appropriately discounted. Before doing this, a method for disentangling the effects of different regulatory procedures must be developed, particularly, the effect of using non-marginal costs of capital to compute the allowed profit on the rate base.

4.2.1 The Regulated Cost of Capital in Theory and Practice

The actual equations used [4.1] instead of (4.1) are,

$$(4.5)\quad \text{APROFIT} = \text{RB} * \text{HWACC},$$

$$(4.6)\quad \text{RB} = \text{UP} - \text{ADEFTAX},$$

$$(4.7)\quad \text{HWACC} = \frac{D}{D+E} * \text{HIIR} + \frac{E}{D+E} * \text{AROE}$$

$$(4.8)\quad \text{HIIR} = 1/D * \sum D_i * c_i,$$

where

APROFIT = allowed profit on rate base;
RB = rate base;
UP = original cost of utility plant;
AROE = allowed return on equity;
HWACC = historical weighted average cost of capital;
ADEFTAX = accumulated deferred taxed on accelerated

depreciation;
D = sum of the book values of all outstanding debt;
E = book value of the common equity of the firm;
HIIR = historical inbedded interest rate;
D_i = book value of debt issue i;
c_i = coupon rate of debt issue i.

The utility is allowed to earn a return on its utility plant at a rate which is based on the coupon rate of prior debt issues and an estimate of the marginal cost of equity to the firm. In a dynamic economic environment, any relationship between HWACC and the marginal cost of capital is mainly coincidental. Moreover, the utility is only allowed to earn this rate on a reduced portion of their assets because customers have effectively advanced funds to the firm to be distributed to later customers, deferred income taxes.

The inclusion of historical coupon rates in HWACC transfers a large component of the financial risk of the bond from the firm to the consumer. Regardless of how interest rates change, the consumer will be held to a fixed, long term financial contract with the bondholders. Since the cost of equity is always marginal, this cannot occur with common equity. To reflect this, AROE must be updated frequently to reflect the opportunity costs of the shareholder.

The exclusion of ADEFTAX from the rate base is designed to make the intertemporal transfer a zero net present value (NPV) transaction. However, since HWACC is not a marginal rate, the deferral, viewed in isolation, may have a non-zero NPV, since the utility is effectively only being charged HWACC to hold the consumer's funds in escrow. Thus, depending on which procedure is eliminated first, the amount of implicit rent attributed to the use of non-marginal rates and the exclusion of deferred taxes from the rate base will differ.

This can be demonstrated by decomposing the change in net cash flow arising from going from equation (4.6) to (4.1). The incremental net cash flow (NCF) is the difference between the two equations,

$$(4.9)\quad NCF^{D} - NCF^{R} = UP * (MWACC - HWACC) + ADEFTAX * HWACC,$$

where

MWACC = marginal weighted average cost of capital.

We choose to first quantify the effects of employing a marginal cost of capital on the rate base. It is defined as

$$(4.10)\quad NCF* - NCF^{R} = RB * [\frac{E}{D+E} * (r^{R} - AROE) + \frac{D}{D+E} (i^{R} - HIIR)]$$

Equation 4.10 could be decomposed further to account for the difference between the use of book capital structure proportions with the historical weighted average cost of capital and the correct use of market value proportions in computing the marginal cost of capital. In the interest of clarity, the analysis proceeds by using the book value proportions in computing the marginal cost of capital, although given the wide disparity wich exists between the book and market values of many long term bonds, the difference between book and market capitalization ratios may not be trivial.

The firm may have assets that are not included in the utility plant and are thus excluded from the rate base. The most important [4.2] example of this is abandoned utility plant. Often, this abandoned plant is excluded from the rate base and earns no return at all. Thus, changing from a historical to a marginal weighted average cost of capital will only partially affect the total amount of securities of the firm, since some of them do not receive a return from the APROFIT equation, regardless of which rate is used.

Next, the reduction of the rate base by deferred taxes is eliminated.

$$(4.11) \quad NCF^{D} - NCF^{*} = ADEFTAX * MWACC.$$

Capitalizing these incremental cash flows, the following three implicit rents can be isolated

$PV^{R}(\Delta EQ)$ = the present value of applying r^{R} on the rate base instead of AROE;
$PV^{R}(\Delta D)$ = the present value of applying i^{R} on the rate base instead of HIIR;
$PV^{R}(RBDT)$ = the present value of not removing deferred taxes from the rate base, based on the marginal WACC.

When discounting the incremental cash flows comprising $PV^{R}(RBDT)$, the after-tax bond rate of the firm is the appropriate rate, since these are certain flows, uncorrelated with market risk. The incremental cash flows arising from forcing $AROE=r^{R}$ should be capitalized at the equity rate for regulated firms as opposed to the equity rate that would arise under deregulation. The equity rate under deregulation will probably be higher than the regulated rate, since the customer will not be bearing so much of the risk.

The present value to the customer of having had the financial risk of long-term bonds transferred by regulation to the firm, simplified by assuming the equality of book and market capital market proportions, can be computed as:

(4.12) $$PVR(\Delta D) = \frac{D}{D+E} \sum_{t} \frac{RB_t * (i^R - HIIR)}{(1 + i^R)^t}$$

4.2.2 Accumulated Deferred Income Taxes

In the previous section, the present value of the incremental cash flows arising from no longer excluding ADEFTAX from the rate base were isolated. They are only one of the streams of incremental cash flows involved in the regulatory treatment of deferred taxes. Over the life of the asset, the deferrals will be amortized, resulting in reductions in allowed revenues. Deregulation eliminates those revenue reductions.

The accumulated deferred income tax liability arises from the use of normalized accounting, a method designed to achieve intertemporal equity by spreading the tax benefits of accelerated depreciation over the lifetime of a plant. The prior section has discussed how this intertemporal transfer is designed not to directly profit the firm

by reducing the allowed profits to offset the time value of the deferral. The incremental cash flows from amortizing the accumulated balance is developed.

Deferred taxes are accumulated according to the formula:

(4.13) $ADEFTAX_t = ADEFTAX_t + DEFTAX_t$

(4.14) $DEFTAX_t = \tau(TAXDEP_t - BKDEP_t)$

where

$TAXDEP_t$ = tax depreciation allowance in year t,

$BKDEP_t$ = book depreciation allowance in year t.

Since

$$(4.15)\quad \sum_{t=1}^{TAXLIFE} TAXDEP_t = \sum_{t=1}^{BKLIFE} BKDEP_t, \quad \sum_{t=1}^{BKLIFE} DEFTAX_t = 0$$

where

TAXLIFE = tax lifetime of asset,
BKLIFE = book life of asset, and
TAXLIFE < BKLIFE by the specifications of the tax code.

Hence, any balance of accumulated deferred taxes will result in revenue reductions over the life of the asset.

These revenue reductions have a present market value. Fortunately, since the term PV(RBDT) is in terms of marginal capital costs, neither needs to be computed independently because their sum must be

$$(4.16)\quad PV(ADEFTAX) = ADEFTAX.$$

Under "laissez faire" deregulation, the total nominal amount of ADEFTAX is expropriated as a rent. In long run competitive equilibrium, a firm would not be able to "accumulate" and then retain the advantages of liberal provisions of the tax code. Of course, if the utility practiced "flow through accounting," there would be no intertemporal transfer to expropriate[4.4].

4.2.3 Accumulated Deferred Investment Tax Credits

The firm generates ITC on construction outlays. Since the ITC is substantial and associated with a particular asset, the same notion which led to normalized tax shields from accelerated depreciation has been applied to ITC. To enhance intertemporal equity, the ITC is amortized over a number of years, resulting in a reduction of revenues for a few years after the ITC was taken.

Section 46(f) of the Internal Revenue Code as ammended by the U.S. Revenue Act of 1971 and the Tax Reduction Act of 1975 contains three regulatory procedures, subject to the election of the utility, not the regulatory commission, which are permissible without the ITC being disallowed. Option 1 is known as "ratable restoration." Normalized ITC would be excluded from the rate base, as is ADEFTAX, but would be restored over the life of the asset. Unlike deferred taxes, however, it would not be amortized by additional reductions in allowed revenues.

Option 2 is known as "ratable flow through." The ITC is not excluded from the rate base, but it is amortized through reductions in allowed revenue. Analysis by [Thomson and Weygandt, 1978] shows that the present value of Option 2 is greater than Option 1 from the perspective of the shareholder.

The last option is to flow all the ITC through to the customer immediately. This provides no direct benefit to the shareholder. This procedure will be used only by the choice of the utility.

Since Option 2 is the most advantageous to the shareholder, and the firm is allowed by law to elect the desired regulatory procedure [4.5], the calculations in this paper will be computed in terms of Option 2. An extension for Option 1 is straightforward. If the ITC is directly flowed through to the consumer, there can be no rent. While this author has not seen the fact documented, it would seem logical that all firms able to exercise an option would choose option 2. In 1980, 178 out of 239 companies used some form of deferred accounting for ITC, although the data does not designate which deferral option was used [U.S. DOE, 1981].

The amortization schedule under Option 2 is known with certainty. Thus, the incremental cash flows to the firm should be discounted at the after-tax bond rate to compute the implicit rent, PV(ANITC). Unlike deferred taxes, PV(ANITC) < ANITC, since under Option 2 procedures, part of the value of the ITC already belongs to the firm.

Accumulated normalized investment tax credits provide an example of the degree of unavoidable arbitrariness which exists around the definition of implicit regulatory rents. Using the same logic as has already been used, one could argue that the implicit regulatory rent from ANITC should equal the whole balance, since the regulatory process which turned over part of the ITC to the shareholder is itself "inadmissable," since under perfect regulation, options 1 and 2 will cause the utility to always earn more than its cost of capital when it has construction programs. This is inconsistent with the notion of long run competitive equilibrium. However, in this specific case, the Federal Government specifically intended to transfer this wealth to shareholder, obstensably to encourage investment in capital goods. Whether or not this subsidy should be continued in a deregulated world is an explicit policy decision.

4.2.4 Extraordinary Property Losses

The regulatory treatment of abandoned construction takes on great importance to utilities that have abandoned substantial amounts of nuclear investments. Since these events are by definition "extraordinary," there are no set rules as to how they are treated. Procedures vary case by case and jurisdiction by jurisdiction.

The best treatment for an abandonment, from the financial perspective of the firm, is for the regulatory commission to include it in the rate base and amortize it over a fixed number of years, with the amortization expense being treated as an allowable expense for ratemaking. In that case, the abandoned plant is worth as much or as little as all the utility assets of the firm. In fact, if a utility is consistently being subjected to an allowed return on equity below its actual cost of equity, an abandoned asset may actually be more valuable than other used and useful assets on a dollar for dollar basis. Abandonments are usually amortized over a much shorter time than their normal book life. This gives the positive cash flows of the write-off less financial depth. Given the inadequate return on all the utility's assets, the abandonment becomes "less of a bad thing."

The treatment of abandonments need not always be so generous to the firm. Often the amortization of the write-off may be an allowed expense but the unamortized balance of the write-off may be excluded from the rate base. Another variation might be to allow the amortization expense, but to only allow a return to the debt portion of the firm's capital tied up in the abandoned plant. Under either of these procedures, the firm will not recover the entire present value of the book value of the abandonment. The worse treatment from the perspective of the firm is if the regulatory commission excludes the abandonment from the rate base and prohibits any amortization of the balance in rates. In this case, regulation thus imposes the draconian treatment that would automatically be imposed under long run competitive equilibrium. Therefore, since the firm has lost the entire present value of the abandonment, deregulation cannot hurt them further.

Whatever method is chosen, it is possible to calculate the incremental after-tax cash flows that the otherwise worthless asset is allowed to generate because of regulation. The regulatory treatment of the abandonment gives an example of an implicit regulatory rent that the shareholder losses to consumers under deregulation.

4.2.5 Changing Replacement Costs

Ignoring the possibility that construction costs on regulated utility plant may be somewhat inflated because the regulated firm may have less incentive to minimize construction costs, either because of X-inefficiency or "gold plating" of the rate base, the replacement cost of the regulated firm's physical assets may change over time, reflecting shifts in the prices of the various factor inputs. A general inflationary tendency in an economy will assure this, although a priori, there is no reason to assume that replacement costs of utility assets will track inflation exactly. Any divergence between inflation and increased construction costs will result in a real capital gain or loss. This is an a posteriori gain or loss, not a measure of the present value of holding utility assets which would have to be computed through the use of a risk adjusted discount rate as opposed to an index of inflation.

The use of a nominal weighted average cost of capital (WACC) in rate making is supposed to cover the effects of inflation on the investor's capital. This would imply that the nominal component of increase in replacement cost of utility plant that would be garnered by the investor under deregulation is an implicit regulatory rent. If the firm expropriates the effects of inflation, it will have been compensated twice for its effects.

The nominal capital appreciation might be considered an implicit regulatory rent, since the investor has, at least in theory, already been compensated for inflation. The logical basis for seeking to redistribute the real capital appreciation is not as clear. One could argue that it too is an implicit rent belonging to the customers since the customer, more than the investor, has had to bear the real asset risks under regulation, and thus is entitled to this component of the gain as well. While this argument is plausible, it is not overshelmingly compelling.

4.2.6 CWIP in the Rate Base

Traditionally, regulatory procedures prohibit charging the customer for the carrying costs of plants under construction. Instead, the original costs the plants construction outlays were increased by an allowance for funds used during construction (AFDC) for purposes of computing allowed depreciation and inclusion in in the rate base. Any reasonable estimate of replacement costs for a non-regulated asset would have to include an allowance for the carrying costs of the asset during construction. AFDC represents real, incurred costs. Thus, ceteris paribus, the book cost of a regulated asset including AFDC would equal the price an equivalent non-regulated firm would be willing to sell the plant for.

In some regulatory jurisdictions, AFDC is not accrued on assets. Rather, the construction work in progress (CWIP) is included in the rate base. This permits the utility to get a return on the plant before it is completed, or to look at it another way, requires the customer to contribute directly to the costs of construction. Financially, it does not matter where the funds are going, to an interest payment on the firm's short-terms or to meet an invoice for construction outlays. When the plant is completed, it will be entered on the books for an amount less than its replacement cost since the firm did not did not supply all the capital. Afterwards, the annual book depreciation for a plant constructed with CWIP in the rate base will be lower than for the equivalent plant where AFDC was capitalized.

Ignoring issues of intertemporal equity, if the AFDC rate used is correct, the two methods of handling the carrying costs of construction are financially equivalent, assuming that the underlying assets remain regulated over their entire book lives. However, under deregulation, if the original cost of an asset excludes AFDC, its replacement cost will be higher, and this difference will accrue to the firm. Under "laissez faire" deregulation, the firm would expropriate consumer contributions to the construction of assets that will no longer be regulated. This should be obvious by considering that some utilities also maintain on their books capital advances from customers. If a utility was deregulated, presumably it would still be obliged to make good on these customer advances. However, the present value of the previously higher electricity bills paid by consumers due to CWIP-in-the-rate-base, although financially equivalent to customer advances to the utility, would appear, under existing law, to remain with the utility.

4.3 Intra-Firm Regulatory Rents

Holders of the firm's common stock are entitled to the residual value of the firm after its more senior securities have been paid off. Therefore, the common stockholders have the most to gain or lose under deregulation.

The value of the firm's debt may also change under deregulation. Corporate debt can be viewed as containing a put option on the value of the firm. The value of the put increases in value as the value of the firm increases, but decreases in value as the firm's volatility increases. Under deregulation, volatility will almost certainly increase, but so also, in many cases, will the value of the firm. Since the two changes work in different directions, it is impossible to sign the net effect on the firm's debt. However, given the marginal borrowing rate of the firm after deregulation, the change in the value of the debt due to deregulation can be computed as

$$(4.21)\quad PV^D(\Delta D) = \sum_{t=1}^{\infty} \frac{INT_t + RFD_t}{(1 + i^R)^t} - \sum_{t=1}^{\infty} \frac{INT_t + RFD_t}{(1 + i^R)^t}$$

where

INT_t = total interest payments on debt in year t;
RFD_t = refunds of debt capital in year t;
i^D = market interest rate on debt of a deregulated firm with capital structure of the regulated firm.
i^R = market interest rate of the regulated firm.

A similar equation could be constructed for the firm's preferred stock. While the owners of preferred do not generally have the right to force default, their securities will behave in a similar manner as the debt, increasing in value as the value of the firm increases but decreasing in value as volatility increases.

In section 4.2.1, implict rents were identified which were associated with changing rates of return from those actually used in rate making to the appropriate marginal rates. The rents identified in this section are the result of changing the required marginal rates because of changes in the underlying risk of the firm brought about by deregulation.

Most outstanding utility debt sells at a large discount from book value due to the secular increase in the nominal interest rate over the past ten years. It would therefore be in the financial interest of the owners of these bonds to invoke bond covenants to frustrate the aims of the shareholders as a bargaining tool for being paid off at a higher than market value. Deregulation might provide such an opportunity, especially if the deregulation proposal involved the divestiture of generating facilities under mortgage bonds. If bond holders were successful, this would be an example of a rent being extracted from the shareholders. Of course, the shareholders would only let this happen in cases where they were, on balance, better off. What the bondholders would accomplish would be to expropriate some of the windfall that would have otherwise remained with the common stockholders.

5. National Estimates of Implicit Regulatory Rents

In this section, estimates are made using 1980 aggregate data. A more precise method for calculating implicit regulatory rents, appropriate at the firm level, will be in section 6. Such detailed data are not available nationally of a company by company basis, although they are available to all utilities and regulatory commissions..

Analysis of aggregate data permits order of magnitude estimates of implicit regulatory rents. Unless otherwise stated, the following analysis will be based on the data compiled by in Statistics of Privately Owned Electric Utility Industry . Present values and replacement costs were calulated as close to the end of 1980 as was possible. The details of the calculations are contained in the tables of appendix six.

The rents were computed for all utility assets, not just generation. Since deregulation proposals will differ in exactly what percentage of utility assets will be deregulated, the estimated rents in this section should be scaled down proportionately. Another issue to be considered is the actual allocation of rents when portions of the assets are deregulated. Actual proposals might not necessarily distribute these rents proportionately.

The most precise method of estimating the difference between the market and book value of outstanding utility securities would be to use actual market data. Since this was not readibly available, net present value methods were used for the bonds, preferred equity and common equity of the industry.

Data on the refunding schedule of outstanding utility long term debt and a historical series of weighted average new issue coupon rates was compiled [see Table A6.1]. To simplify estimation, all bonds were assumed to be non-callable thirty year fixed coupon bonds with one balloon payment at the end of their thirtieth year. Applying the actual weighted average new issue rate of thirty years prior to the amount being refunded, the annual interest payment of each years bonds was estimated. The thus computed interest payments and the balloon payment were then discounted at the weighted average utility bond rate of 1980, 13.46%. To normalize for data incompleteness, a price/book ratio of 0.68 for the total book value of the refunding schedule was computed. This ratio was then applied to the balance of outstanding long term debt of $105,257,047,831. Accordingly, the implicit rent arising from the use of historical inbedded interest rates in ratemaking is $33.6 billion.

The calculations for preferred and common equity are much simpler, since the time issuance profile of these securities is not important. In 1980, $2,046,357,318 of preferred dividends were paid out on a balance of $25,439,546,508. Assuming that all preferred stocks were perpetuities without call provisions, conversion provisions, or sinking funds, this amounts to an aggregated yield of 8.04%. Taking the mean of Moody's average preferred yields in 1980,

High Quality	13.15%,
Good Quality	14.01%,
Medium Quality	14.56%,

to be 13.91%, the total preferred stock should sell on the market for about 57% of book value. Therefore, the implicit rent arising from the use of historical inbedded preferred dividend rates is about $10.7 billion.

Book equity totalled $79,043,913,514, including retained earnings and sundry other equity accounts. The best available estimate of price/book ratio of 0.78 was based on the top one-hundred utilities. Unfortunately, it is only an arithmetic average. Using this crude estimate, the aggregate shareholder "loss" from returns below the cost of equity capital is about $17.4 billion.

The balance of accumulated deferred taxes for accelerated depreciation is $14,177,424,000 including the deferred taxes which arose from non-electric properties. This balance must be adjusted for three factors. Not every utility is permitted to normalize deferred taxes for rate-making. Company specific data on applicable rate-making treatment was only available for the top one-hundred firms and is summarized in table A6.2. The $963,390,893 of deferred taxes of these firms must be excluded from our estimate. Some firms are not required to exclude the deferred taxes from their rate base. In those few cases, the regulatory process has already expropriated a portion of the deferred taxes and given them to the firm. Other firms are only allowed to normalize a portion of their deferred taxes. In those cases, the benefits arising from the use of shorter tax lives are flowed through immediately, while the benefits of accelerated depreciation are normalized. Since aggregate data is not available on either of these phenomena, the estimated rent of

$13.2 billion will be on the high side.

$6,690 million dollars of investment tax credits (ITC) were normalized for electric utility property. Unfortunately, the data collected by the Energy Information Agency does not precisely designate which regulatory option is applicable to the firm. Assuming that the ITC is treated as a contribution to the utility's overall capital mix (as opposed to only equity capital) and subject to Option 2 treatment, the implicit rent can be calculated as the difference between the book value of the ITC and the present value of the future revenue reductions required to flow through the ITC to the consumer. Using a marginal after-tax cost of capital of 9.17% [see table A6.3] and an amortization period of fifteen years, the present value of the future revenue reductions is about $4.5 billion. Subtracting this from the book value of the ITC normalized, the implicit rent from ITC is about $2.2 billion.

Extraordinary losses totalled $1,394,292,685 as of December 31,1980. This again is for all property owned by electric utilities. The overwhelming majority of this is attributable to electric properties. Assuming that regulators permit this to be amortized over ten years but exclude the unamortized balance from the rate base, the implicit rent which the firms would lose under deregulation is about $0.9 billion . While this sum is the lowest of all the estimated rents, it may be somewhat important because these losses would be concentrated on a few firms that have written off nuclear projects.

Data on the amount of CWIP-in-the-rate-base was not available. These rents are probably not too large because this regulatory procedure is relatively new.

Using a time series of new construction expenditures by utilties over the past thirty years, an estimate of the replacement cost of the existing utility plant was made [see Table A6.4]. Thirty year straight line depreciation was assumed for all assets. A replacement cost factor as of January 1, 1981 was computed using the Handy-Whitman Index of Public Utility Construction Costs. Because the index is divided into six regional components, a national index was constructed using the mean of the six regions. Dividing this index by the index value on January 1, 1981 yields a replacement cost factor. The expected non-depreciated remainder of each year's investments was multiplied by this factor to estimate what it would cost to replace the asset. To normalize the time series, a replacement cost/gross book investment ratio of 1.24 was computed. Applying this ratio to the 1980 Total Gross Electric Plant (including Nuclear Fuel) of $266,921,690,736, the estimated replacement cost was about $330.1 billion.

1980 Utility Plant Replacement Cost	331.0
Less: 1980 Utility Plant Book Value	211.5
Replacement Cost Implicit Regulatory Rent	119.5 billion

This very large number is obviously an extreme upper bound. Many of today's facilities would not be replaced, either because of technological obsolescence or local over-capacity. A better estimate of this figure would have to somehow account for these phenomena.

This rent can be divided into an inflationary component and a real capital appreciation component. Repeating the above procedure using the GNP deflator as an index of economy-wide inflation, the value of the existing utility plant was computed in third quarter 1980 dollars using a nominal cost/gross investment ratio of 0.92 [see Table A6.5].

1980 Utility Plant Nominal Cost	245.6
Less: 1980 Utility Plant Book Value	211.5
Inflationary Component of Replacement Cost Implicit Regulatory Rent	34.1 billion

Subtracting this from the total replacement cost implicit regulatory rent computed above, the real capital appreciation component can be backed out.

Replacement Cost Implicit Regulatory Rent	119.5
Less: Inflationary Component of Replacement Cost Implicit Regulatory Rent	34.1
Real Capital Appreciation Component of Replacement Cost Implicit Regulatory Rent	85.4 billion

To correctly interpret Table 5.1, it must be noted that each class of securities were treated as if they were worth their book value, which they are not. This avoids double counting the implicit regulatory rents attributed to the used of historical inbedded rates and returns on equity below the cost of equity.

Table 5.2 summarizes the aggregate national estimates of customer-firm implicit regulatory rents. To put these numbers into perspective, they are also expressed as a percent of the total market value of all electric utility common equity. Replacement cost implicit regulatory rents dominate the results, accounting for 61% of total implicit regulatory rents.

Upon presenting such an impressive figure as $196 billion, the risk of misinterpretation outweighs the need to avoid redundancy. As stated in section 1, implicit regulatory rents are not the same as the expected actual financial dislocation that would occur if the industry was deregulated. The method for calculating that figure was described in section 3. Unfortunately, those calculations, while relatively straight forward in theory, are very difficult to actually execute at the national level. What I think is a fair inference from the magnitude of the estimated implicit regulatory rent is two-fold. First, and this is no suprise to anyone who is knowledgeable about the electric utility , is that deregulation has the potential to create huge financial gains or losses, although it is not certain who, in fact, are the winners and the losers. Second, and perhaps not as well recognized, is that any deregulation proposal must be exceedingly concerned with the details of the prior regulatory regime, since, as we have seen, some very large sums of money which may look alike, may mean very different things depending upon how the regulatory processed defined them.

Intra-firm regulatory rents are difficult to estimate, even on a firm by firm level. The best way to get a sense of what they might be is to consider table 5.2. The sensitivity of the present value of the existing outstanding fixed coupon security securities is computed for a range of changes in their market required rate of return under deregulation. Since the rents are transfers between the owners of the firm, the loss of the bondholders and preferred shareholders is the gain of the common stockholders. As described in section 4.2, in the absense of more detailed analysis, it is impossible to determine for sure whether the bondholders and preferred shareholders are helped or hurt by deregulation.

Table 5.1

Summary of Aggregate National Customer-Firm Implicit Regulatory Rents

(Billions of Dollars)

		MV(EQ)
Regulated Cost of Capital		
Historical Inbedded Interest Rates	33.6	54%
Historical Inbedded Preferred Dividends	10.7	17%
Earned Return on Equity Below Cost	17.4	28%
	61.7	99%
Accumulated Deferred Taxes from Accelerated Depreciation	13.2	21%
Customer Share of Investment Tax Credits	2.2	4%
Utility Share of Amortization of Abandonments	-0.9	-1%
Excess of Replacement Over Book Cost		
Inflationary Component	34.1	55%
Real Capital Appreciation Component	85.4	138%
TOTAL CUSTOMER-FIRM IMPLICIT REGULATORY RENTS	195.7	317%

MV(EQ) = Market Value of Common Equity was computed as price-book ratio times the aggregate book value of equity (.78 * $79,043,913,514 = $61.7 billion)

Table 5.2
Range of Intra-Firm Implicit Regulatory Rents Arising from Deregulation
(Billions of Dollars)

	Debt	Preferred	Common
Regulated Cost of Capital	13.46%	13.91%	NA
Book Value of Capital	105.3	25.4	79.0
Change in Discount Rate			
-3%	19.2	4.5	-23.7
-2%	13.6	3.2	-16.8
-1%	7.3	1.7	-9.0
0%	0.0	0.0	0.0
+1%	-7.3	-1.7	9.0
+2%	-13.6	-3.2	16.8
+3%	-19.2	-4.5	23.7

6. Calculating Implicit Regulatory Rents at the Firm Level

To provide a guide for implementing the proceding analysis for a utility, a numerical example is developed of calculating the implicit regulatory rents which arise from deregulating a "one shot" project [Navarro, Peterson, and Stauffer, 1981] previously subject to rate-of-return regulation. In the absence of a working model of the EBIT arising under deregulation, no numerical examples of the total financial impact on firms, consumers, and tax revenues are presented. However, as mentioned, operational models of revenues and costs under deregulation are currently being developed; this paper presents a framework for utilizing their output in measuring the impact of deregulation.

6.1 The Regulatory Model

Regulatory procedures are not uniform across the various jurisdictions, nor even consistent among firms in the same jurisdiction. To perform a cash flow analysis of a regulated firm, the specific details of the regulatory procedures used must be understood. In this section, cash flows are developed for a firm under a fairly standard set of regulatory procedures. The method of modeling is not new; see [Baughman, Joskow, and Kamat, 1979; National Economic Research Associates, Inc., 1979; Putnam, Hayes, and Bartlett, Inc., 1980]. The model developed here is deterministic. Moreover, all the simultaneous difference equations are recursive, permiting solution by stepwise substitution.

Before describing the workings of the model, one major caveat on its applicability is required. In order for the results of the model developed in this section to produce meaningful estimates of cash flows, regulation must prove in practice to be the binding determinant of revenues. As [Joskow, 1976] points out, rate of return regulation was not binding on many electric utilities in the late 50's and early 60's. He suggests a behavioral theory of regulation to explain this. More generally, regulation cannot allow rates above the monopoly price and still expect the firm to earn its cost of capital. Regulation is a binding constraint on profits for most electric utilities today.

Figure 6.1 is a flow chart for the regulatory model. Each year of simulation is modelled on the first and last day of the year. The timing of events is detailed in figure 6.2. To avoid unnecessary complications in the model, the schedule of new financing, amounts of new construction, booking and abandonment of plants are exogeneous to the model, although it is possible to endogenize these functions in a more complete model of regulated behavior.

These exogeneous transactions are posted on the first day of the year, updating the end of year balance sheet of t-1. Based on this beginning of period rate base, a computation of allowed revenues is made. In regulatory parlance, this procedure would be described as an end of year rate base [6.1] with a future test year. This is an admissable regulatory scheme.

At the end of the year, the actual financial performance of the utility is compared with the original goal of rate making. In our model, it is assumed that the firm earns exactly the level of revenues allowed by the regulatory commission. A rate case is held every year. By assuming that expected operations and maintenance (O&M) expenses equal actual O&M, the firm's net income should equal the allowed return to equity, with two small exceptions that will be discussed later. The net income, when adjusted for non-cash revenues and expenses on the sources of funds statement, yields the net cash flow to the debt and equity holders of the firm, given a prespecified policy for capital structure and dividends. The firm in our model will maintain a constant proportion of debt to equity of 3:1 in terms of book values by issuing or repurchasing stock and bonds every year. While financial theory would direct a market value rule, tractability requires the use of a book value rule. The firm will pay out all its net income as dividends. In the context of this model, this policy has no cash flow implications, since all excess cash will be refunded to the shareholder to maintain the capital structure.

The two reasons built into the model why the allowed return to equity will not exactly equal net income are due to the regulatory treatment of abandoned assets and normalized investment tax credits. Abandoned assets are not included into the rate base. Thus, the interest allowance in rate making is less than the actual interest charge on the income statement, adjusted on an after-tax basis. The situation with normalized ITC is similar but reversed, since the normalized ITC represents funds which will be refunded to customers in future years. In the interim, the unamortized balance is effectively included in the rate base. Thus, the normalized ITC will result in an increase in the after tax interest allowance. This regulatory treatment corresponds to the so-called "Option 2" ratable flow through method. Moreover, the normalized ITC is assumed to be a contribution to the firm's capital mix, as opposed to a contribution to equity capital only. Deferred taxes are normalized, so the rate base is reduced accordingly. The full set of equations to the model are in Appendix 2. A detailed, step by step discussion of the simulation is in Appendix 3. Tables showing the computation of implicit rents are in Appendix 4.

6.2 Calculating Implicit Regulatory Rents

Some of the implicit rents arise from changes in general economic parameters, since regulation transfers risk to consumers and the present value of predetermined intertemporal transfers changes when economy wide required rates of return change. Four different economic scenarios are examined. Each scenario, as summarized in Figure 6.3, specifies a value for each of the following variables:

r^R = required return on equity for a regulated firm;
r^D = required return on equity for a deregulated firm;
i^R = required return on debt for a regulated firm;
i^D = required return on debt for a deregulated firm;
HW = rate of change of the Handy-Whitman Index of Utility Construction Costs, assumed constant;
GNP = rate of change of the GNP deflator, assumed constant.

These economic parameters are to be compared or contrasted with two regulator parameters which are constant throughout the regulatory process,

Figure 6.1

Financial Model Flow Chart

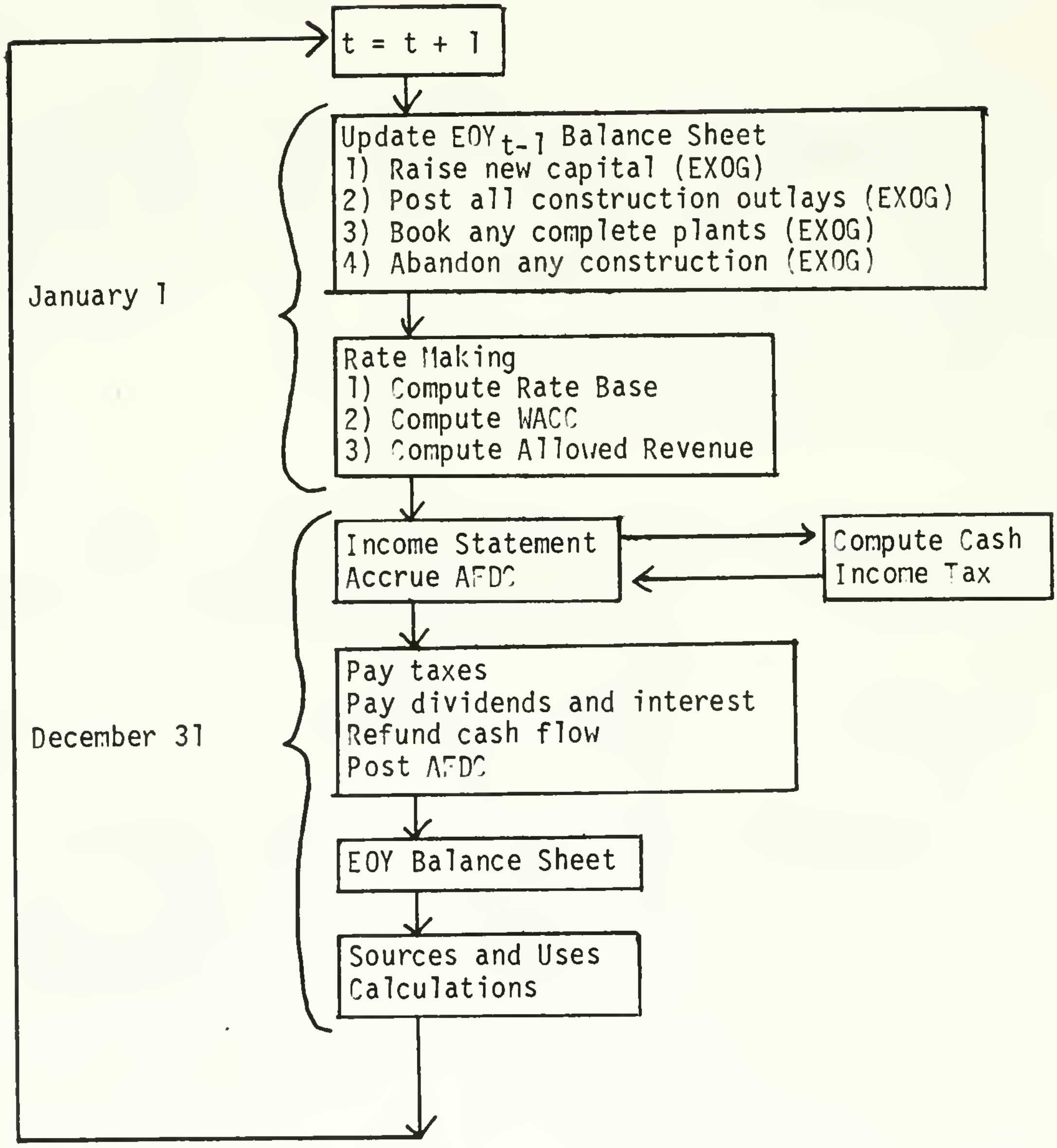
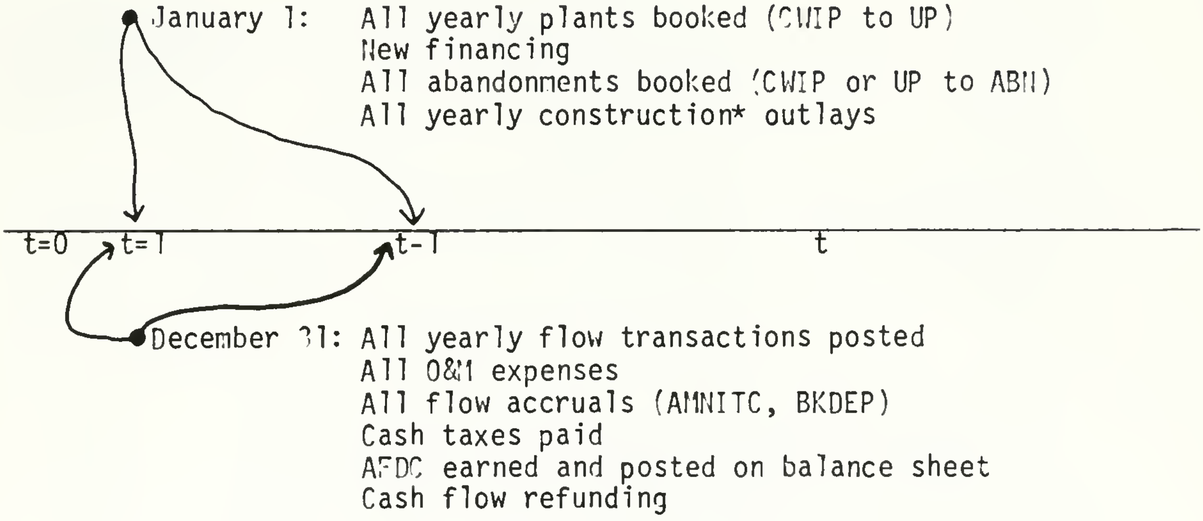

t = t + 1
Update EOY$_{t-1}$ Balance Sheet
1) Raise new capital (EXOG)
2) Post all construction outlays (EXOG)
3) Book any complete plants (EXOG)
4) Abandon any construction (EXOG)
January 1
Rate Making
1) Compute Rate Base
2) Compute WACC
3) Compute Allowed Revenue
Income Statement
Accrue AFDC
Compute Cash
Income Tax
December 31
Pay taxes
Pay dividends and interest
Refund cash flow
Post AFDC
EOY Balance Sheet
Sources and Uses
Calculations

Figure 6.2

Timing Assumptions of Financial Model

All transactions in the model take place at the beginning and end of the year. The beginnning of the year can be thought of as January 1; the end corresponds to December 31. Rate making is based on the January 1 rate base.



January 1:
All yearly plants booked (CWIP to UP)
New financing
All abandonments booked (CWIP or UP to ABN)
All yearly construction* outlays

December 31:
All yearly flow transactions posted
All O&M expenses
All flow accruals (AMNITC, BKDEP)
Cash taxes paid
AFDC earned and posted on balance sheet
Cash flow refunding

---

*New financing can either be thought of as going directly into new construction, or in and out of the cash account the same day.

AROE = 15% Allowed Return on Equity
HIIR = 7.5% Historical Imbedded Interest Rate.

In this example, the regulatory commission based all its calculations on the assumption that the cost of equity was .15. Depending on whether or not this rate coincides with the market determined required rate of return on equity, an implicit rent may arise.

In scenarios 1a and 1b, since the required return of equity was .15, no implicit rent due to changes in the market cost of capital would arise. However, in scenarios 2 and 3, the required return on equity under regulation is .175. On table A4.1, the incremental cash flow that would arise if the regulatory commission used the correct return on equity is computed. The amount of book equity is multiplied by .175 to yield the required net income.

Ratemaking is based on the historical imbedded interest rate, which in this model is .075. The ratepayers have essentially made a capital gain in the bond market, since the opportunity cost of the capital is the marginal cost of debt at all times. On table A4.1, these incremental cash flows are capitalized at the marginal debt rate.

The implicit rent on deferred taxes is their book value, which at the beginning of period 4 is $48.22. The implicit rent from normalized ITC is the present value of the required revenue reductions discounted at the after tax bond rate, calculated in table A4.2.

In this example, the regulatory commission permits the utility to amortize the construction costs, net of the tax shield on write-offs. Discounting these flows at the after tax bond rate, the present value of the writeoff to the firm is calculated as:

	$MV^R(ABN)$
Scenario 1a, 1b	41.91
Scenario 2	40.46
Scenario 3	39.63

By assumption, the abandonment would be valueless under the deregulation.

The book value of net plant is service at BOY4 was $771.43. Under scenarios 1a and 2 the Handy-Whitman Index remains constant, as does the GNP deflator Thus, the replacement cost of the net plant in service would equal its book value, assuming that the book depreciation equals the economic depreciation of the asset. In scenario 1b and 3 the replacement cost of the assets would be

$$RC = (1 + HW)^t \text{ NPIS}$$

$$= 1.125 * 771.43 = 867.86.$$

The increase in replacement cost would be

$$= 867.86 - 771.43$$

$$= 96.43.$$

This increase in replacement cost is composed of nominal capital appreciation of 77.14 based on a 10% GNP deflator. The real capital appreciation therefore was 19.29. In this example, index numbers were used to determine replacement costs. In practice, the use of index numbers is only one of the many methods which can be used to estimate replacement costs. An engineering study could be commissioned to

Figure 6.3

Deregulation Scenarios

Scenario	Economic Parameters	Regulatory Parameters
1a	$r^R = r^D = 15.0\%$	AROE = 15.0%
	$i^R = i^D = 7.5\%$	HIRR = 7.5%
	HW = 0%	
	GNP = 0%	
1b	$r^R = r^D = 15.0\%$	AROE = 15.0%
	$i^R = i^D = 7.5\%$	HIRR = 7.5%
	HW = 12.5%	
	GNP = 10%	
2	$r^R = r^D = 17.5\%$	AROE = 15.0%
	$i^R = i^D = 10.0\%$	HIRR = 7.5%
	HW = 0%	
	GNP = 0%	
3	$r^R = 17.5\%$	AROE = 15.0%
	$r^D = 20.0\%$	
	$i^R = 10.\%$	HIIR = 7.5%
	$i^D = 12.5\%$	
	HW = 12.5%	
	GNP = 10.5%	

provide a better measure of replacement value.

In this example, AFDC was capitalized. Thus, no CWIP-in-the-rate-base expropriation occurs. Capitalized AFDC at the beginning of year 4 was $86.79. These funds, which were laid out by the shareholders, should belong to the shareholders under deregulation.

In scenario 3, the required rate of interest on the securities of the deregulated firm's debt is higher than that of the regulated firm. Therefore, the present value of the cash flows to these securities is less. This creates an intra-firm regulatory rent. The present value of the equity increases due to the loss on the part of the bondholders, which is calculated in table A4.4.

Tables 6.1 and 6.2 summarize all the implicit regulatory rents in this example. By construction, the net total rents were positive. In the scenarios where the nominal value of the utility plant increases, those rents dominate the others. The loss of amortization of abandoned plant hurts the firm under deregulation, as does the decreased present value of their securities because of increased risk.

These implicit regulatory rents are only meaningful in the face of large changes in the value of the firm under deregulation. In this example, no model was developed to estimate the EBIT of the firm under deregulation. The output of the EBIT model permits the dislocations caused by deregulation to be measured. Without a measure of the total regulatory rents, the disposition of the implicit rents may be moot. If deregulation does not cause dislocations, there will be no need to design a compensation scheme.

Table 6.1

Summary of Simulation

Customer-Firm Implicit Regulatory Rents

	Scenario 1a	Scenario 1b
Regulated Cost of Capital		
Historical Inbedded Interest Rates	0.0	0.0
Earned Return on Equity Below Cost	0.0	0.0
	0.0	0.0
Accumulated Deferred Taxes from Accelerated Depreciation	48.2	48.2
Customer Share of Investment Tax Credits	68.0	68.0
Utility Share of Amortization of Abandonments	-44.7	-44.7
Excess of Replacement Over Book Cost		
Inflationary Component	0.0	77.1
Real Capital Appreciation Component	0.0	19.3
TOTAL CUSTOMER-FIRM IMPLICIT REGULATORY RENTS	23.2	119.7

Table 6.2

Summary of Simulation

Customer-Firm Implicit Regulatory Rents

	Scenario 2	Scenario 3
Regulated Cost of Capital		
Historical Inbedded Interest Rates	36.0	37.9
Earned Return on Equity Below Cost	10.9	10.4
	46.9	48.3
Accumulated Deferred Taxes from Accelerated Depreciation	43.2	48.2
Customer Share of Investment Tax Credits	65.2	62.7
Utility Share of Amortization of Abandonments	-43.4	-42.2
Excess of Replacement Over Book Cost		
Inflationary Component	0.0	77.1
Real Capital Appreciation Component	0.0	19.3
TOTAL IMPLICIT REGULATORY RENTS	118.9	169.5
INTRA-FIRM IMPLICIT REGULATORY RENT		
Long Term Debt	0.0	-32.4
Common Stock	0.0	+32.4

7. Conclusion

This paper has developed a framework for linking together a number of disparate and individually obvious problems associated with deregulating previously regulated utility assets. The notion of implicit regulatory rents was set forth to represent the financial claims arising from an implicit regulatory contract between the firm and its customers. Undoubtedly, future litgants will argue that some of these financial claims should be recognized in any deregulation scheme implemented. Recognizing these claims provides the basis for a program to compensate those adversely affected.

Calculating implicit regulatory rents, while simpler than calculating actual expected financial dislocations, is still tedious and difficult. Why, it may be asked, it this theory proposed, when a much simpler solution to allocating windfalls caused by deregulation would be to compensate shareholders at book value. A competitive auction could be held for the assets to be deregulated, and the shareholders could be paid out of the proceeds.

This particular allocation procedure is just one particular form that a deregulation proposal that recognizes certain implicit rents could take. It is equivalent to compensating shareholders for earnings below the cost of equity capital, but no more. All the remaining windfall that would have gone to the firm under "laissez faire" deregulation instead goes to customers and the government. Consumers would thus expropriate all the remaining implicit regulatory rents, as well as the remaining actual producer's surplus.

This, however, need not be the only outcome. While every deregulated utility will be different, there may very well be substantial windfall gains to the utility owners after all the implicit regulatory rents have been recognized and redistributed. If the final outcome of the oil and natural gas deregulation battles is any indicator, the American political process does not find all producer windfalls which arise from efficiency improving changes anathema. This is not to say, though, that they were not contraversial, nor that windfall gains to existing producers will not have to be dealt with somehow.

Any deregulation scheme that requires restructuring existing firms will not be realizable if it is opposed by many of those firms' managements, regardless of any theoretical efficiency enhancing properties. It is my belief that only substantial shareholder interest can provide the motivation for existing managements to accept structural change. Unlike the case of AT&T where there was one centralized management, there are about two hundred monopolists that have to be dealt with to reform the electric utility industry. The resulting delaying tactics that these managements could produce would stretch the Government's resources beyond what could reasonably be expected. Therefore, the use of arguments based around the theory of implicit regulatory rents to justify some windfall to the firm might be vital to induce shareholder's support.

At the other extreme, the theory of implicit regulatory rents can be used to assure that firms do not expropriate all the windfall generated by deregulation. While I do not think that consumer groups and state regulatory commissions alone could force deregulation upon unwilling firms, they could hinder, and perhaps halt the process. They must be convinced that they are getting a reasonably fair deal. The theory of implicit regulatory rents provides a framework for structuring arguments about what "fair" means.

Although section 3 provides a methodology for measuring the total windfall available to be distributed, I have not provided any empirical estimate of their magnitude. Intuition would lead one to believe that it is large. Clearly, empirical work is required to confirm or deny this intuition. If the windfall is small, or even negative, the implications for achieving deregulation are very different.

Assuming that the windfall is estimated, implicit regulatory rents are measured, and the political process is in agreement about which of these rents should be recognized under deregulation, there remains the difficult problem of devising a method for directing these benefits to the appropriate parties. Relegating the theoretically ideal method of direct lump-sum transfers to the textbooks, any practical scheme would alter the pricing structure of the newly freed prices, potentially creating new inefficiencies. In the case of AT&T, this problem might be dealt with by having the rate base of the regulated firms reduced by the difference between the replacement and book cost of assets bought by deregulated Bell. The resulting subsidization of local service might be politically desirable.

Following a similar procedure may be difficult with electric utilities because transmission and distribution charges represent a small proportion of the delivered cost of electricity. The ability of a regulated transmission and distribution (T&D) company to absorb a consumer subsidy must be studied carefully.

The subsidization of the T&D system could cause difficulty for deregulation and divestiture schemes [Golub, et.al., 1981] which rely on T&D pricing to control the stability of the electrical network. Reducing the rate base of the T&D reduces allowed profits. A thus tightened regulatory constraint might hinder the use of efficient price signals to independent generators whose electrical behavior must be controlled by the T&D.

While much research remains to be done, this analysis does not bode well for advocates of deregulating previously regulated assets. The burden of proof is now heavier, because the problems discussed in this paper must be thoroughly analyzed for every utility system to be deregulated.

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FOOTNOTES

Chapter 1

1.1 [Pace, 1981] reviews much of this literature. Other discussions of this topic appear in Golub, et al., 1981; Gillen, 1981; Hyman, 1981; Leinweber, 1980; Shuler and Hobbs, 1981; in West Germany, Shulz, 1980].

1.2 [Hyman, 1981] uses the same taxonomy as the one developed here.

1.3 This may not that tenuous an assumption. The Swedish power system has a State-run national grid, with independent (private and municipal) bulk power producers. They have developed a sophisticated method for charging bulk power producers for use and expansion of the grid. The "Main Grid Agreement" will apply to present and future bulk producers from 1981-December 31, 2004.

Chapter 2

2.1 Public Utility Regulatory Policies Act of 1978. Public Law 95-617.

2.2 Guy W. Nichols, CEO of the New England Electric System, as quoted by [Cavanaugh, 1981].

Chapter 3

3.1 Currently, electric generating plants are dispatched in order of lowest marginal cost. This minimizes total operating costs. Under competitive spot pricing, plant will offer their output whenever the market price is above their marginal cost. While spot pricing is common in many markets, such as financial securities, commodities, etc., it is a relatively new idea for pricing electricity. Readers are encouraged to read [Bohn, Caramanis and Schweppe, 1981] for a formal treatment of the subject. [Vickrey, 1971] is generally acknowledged as first suggesting this.

3.2 A determinate analysis can also be made using a Cournot-Nash behavioral assumption. Currently, an an empirical analysis using this approach is being undertaken.

3.3 Predatory pricing could arise in theory, but it would seem that once a plant was built, it would be hard to force it out of the market since it literally has no place to go.

3.4 This is the beta of the capital asset pricing model.

3.5 A good discussion of these issues is found in [Brealey and Myers, 1981] Chapter 19.

Chapter 4

4.1 Omitted for the time being is the allowance for Federal Income Taxes, ATAXES, equation. The allowance covers the tax liability that will arise to yield the after-tax return on equity at the required rate, $ATAXES^{EQ}$. It may include another adjustment because expenses and revenues recognized in rate making do not coincide exactly with those that are recognized in determining taxable income, $ATAXES^{O}$ (this equation is derived in appendix 2). To make the APROFIT equation meaningful, it should be noted that

$$EBIT = APROFIT + ATAXES^{EQ},$$

since APROFIT by itself is a mixed quantity, with the interest portion being on a before-tax basis while the equity return is on an after-tax basis. Adding in $ATAXES^{EQ}$ converts the equity component to a before-tax basis which is recognizable as earnings before interest and taxes.

4.2 Construction work in progress is also often excluded from the rate base. However, the utility is credited with an allowance for funds used during construction which accumulates and is entered into the rate base when the plant is completed.

4.3 Normalization does aid the firm by reducing its default risk. See [berndt, Sharp, and Watkins, 1979].

4.4 Some regulatory commissions do not reduce the rate base by ADEFTAX. In that case, PV(ADEFTAX) does not equal ADEFTAX because the firm already owns, in effect, some of the ADEFTAX under regulation.

4.6 This did not arise because of altriusm by the regulatory commission to shareholders. Congress passed special legislation to eliminate the investment tax credit to utilities that were forced to completely flow them through to consumers. [Thomson and Weygandt, 1978] criticize this procedure, arguing that it makes no sense for the shareholders to get ITC when they are obliged to build capacity to meet demand.

Chapter 6

6.1 This is because last years end of year rate base has been updated exactly for expected new plants. Also, the expected expenses are allowed, as opposed to historic expenses.

APPENDIX 1 DERIVATION OF TAX FRACTION OF EBIT

By definition,

(A1.1) $\text{EBIT} = \text{EQRET} + \text{INT} + \text{TAX}.$

The equity return = $\text{EQRET} = r^D * \text{EQ}.$

The total interest = $\text{INT} = i * D.$

The tax liability = $\text{TAX} = (\tau/(1-\tau) * \text{EQRET}.$

The firm's capitalization = $\text{CAPITAL} = \text{EQ} + D.$

The desired fraction is

(A1.2) $\text{TAXFRAC} = \text{TAX}/\text{EBIT}$

$$= \frac{(\tau/(1-\tau)) * r^D * \text{EQ}}{(1/(1-\tau)) * r^D * \text{EQ} + i * D}$$

Divide through by CAPITAL, yielding,

(A1.3) $$\text{TAXFRAC} = \frac{(\tau/(1-\tau)) * r^D * \text{EQSHAR}}{(1/(1-\tau)) * r^D * \text{EQSHAR} + i * (1 - \text{EQSHAR})}$$

where

$\text{EQSHAR} = \text{EQ}/\text{CAPITAL}$

is the equity share of capital. (1 - EQSHAR) is thus the debt share of capital.

APPENDIX 2 The Regulatory Cash Flow Model

A2.1 Variable Definitions in Alphabetical Order

$AAFDC_t$	Accumulated Allowance for Funds used During Construction in year t
ABN_t	Abandoned Assets in year t
$ABNAFDC_t$	AAFDC to be Abandoned in year t
$ABNCWIP_t$	CWIP to be Abandoned in year t
$AFDCRAT_t$	After Tax AFDC Rate in year t
$AMABN_t$	Amortization of After Tax Abandonment in year t
$AMNITC_t$	Amortization of Normalized ITC in year t
$ANITC_t$	Accumulated Deferred Income Taxes
$APROFIT_t$	Allowed Profit
$AREV_t$	Allowed Revenues
AROE	Allowed Return on Equity
$ASSETS_t$	Assets in year t
$ATAXES_t^{EQ}$	Allowed Taxes on Equity Earnings
$ATAXES_t^{O}$	Allowed Taxes on Non-Deductible Expenses
$BKAMORT_t$	Amortizaiton of CAFDC in year t
$BKDEP_t$	Book Depreciation in year t
BKLIFE	Book Life of Asset
$CAFDC_t$	Capitalized Allowance for Fund Used during Construction
$CITAX_t$	Cash Federal Tax Payment in year t
$CWIP_t$	Construction Work in Progress in year t
$DEFTABN_t$	Deferred Tax Shield From Abondonment Loss in year t
$DEFTAX_t$	Deferred Tax from Accelerated Depreciation in year t
DIV_t	Dividend Payments in year t
EBT_t	Earnings Before Taxes in year t
EQ_t	Equity Capital
EQSHAR	Equity Share of Capital
$ESOURC_t$	External Source of Funds in year t
${}_iD_t$	Debt of Issue type i

INT_t	Interest Payable in year t
$ISORC_t$	Internal Source of Funds in year t
ITCRATE	Tax rate of ITC
$LIAB_t$	Liabilities
$NPIS_t$	Net Plant in Service in year t
$NUPLANT_t$	New Utility Plant in year t
OM_t	Operation and Maintenance Expenses
$RAFDC_t$	Reported AFDC in year t
RB_t	Rate Base
REV_t	Actual revenues of Firm in year t
RFD_t	Refunded Debt in year t
$RFEQ_t$	Refunded Equity Capital in year t
SC_t	Working Capital in year t
$SOYD_i$	Sum of Years Digits factor in year i
τ	Federal Corporate Income Tax Rate
$TAXINC_t$	Taxable Income in year t
TDL_t	Total Deferred Liabilities in year t
TPC_t	Toal Proprietary Capital in year t
$TSOURC_t$	Total Source of Funds in year t
$TUSES_t$	Total Uses of Funds in year t
$TXDEP_t$	Tax Depreciation in year t
$TXLIAB_t$	Federal Tax Liability in year t
UP_t	Utility Plant in year t
$WACC_t$	Weighted Average Cost of Capital in year t
c_i	Coupon Rate of Debt Issue i

A2.2 Regulatory Cash Flow Model Equations

A. BALANCE SHEET UPDATE - BEGINNING OF PERIOD

1. Assets

(A2.1) $NPIS_t = NPIS_{t-1}$

(A2.2) $CAFDC_t = CAFD_{t-1}$

(A2.3) $CWIP_t = CWIP_{t-1} + NUCON_t$

(A2.4) $AAFDC_t = AAFDC_{t-1}$

(A2.5) $WC_t = WC_{t-1} + NC_t - NUCON_t$

(A2.6) $ABN_t = ABN_{t-1}$

2. Liabilities

(A2.7) $D_t = D_{t-1} + (1-EQSHAR) * NC_t$

(A2.8) $EQ_t = EQ_{t-1} + EQSHAR * NC_t$

(A2.9) $ANITC_t = ANIC_{t-1}$

(A2.10) $ADEFTAX_t = ADEFTAX_{t-1}$

B. IF A PLANT IS BOOKED OR ABANDONED

1. Update Balance Sheet

(A2.11) $NPIS_t = NPIS_t + BKPLANT_t - ABNCWIP_t$

(A2.12) $CAFDC_t = CAFDC_t + AAFDC_t - ABNAFDC_t$

(A2.13) $ABN_t = ABN_t + ABNCWIP_t + ABNAFDC_t$

2. Update Depreciation and Amortization Schedules

(A2.14) $BKDEP_{t+i} = BKDEP_{t+i} + \frac{CWIP_t - ABNCWIP_t}{BKLIFE}$ $i=0...BKLIFE-1$

(A2.15) $BKAMORT_{t+i} = BKAMORT_{t+i} + \frac{AAFDC_t - ABNAFDC_t}{BKLIFE}$ $i=0...BKLIFE-1$

(A2.16) $TXDEP_{t+i} = TXDEP_{t+i} + SOYD_i * (CWIP_t - ABNCWIP_t)$, $i=0..TXLIFE-1$

(A2.17) $NITC_t = ITCRATE * (CWIP_t - ABNCWIP_t)$

(A2.18) $AMNITC_{t+i} = AMNITC_{t+i} + \frac{NITC_t}{ITCLIFE}$ $i=0...ITCLIFE-1$

(A2.19) $CWIP_t = CWIP_t - BKPLANT_t$

(A2.20) $AAFDC_t = 0$

(A2.21) $DEFTABN_t = \tau * ABNCWIP_t$

(A2.22) $AMABN_{t+i} = AMABN_{t+i} + \frac{1-\tau * ABNCWIP_t + ABNAFDL_t}{ABNLIFE} \quad i=0..ABNLIFE-1$

(A2.23) $DEFTAX_t = \tau(TAXDEP_t - BKDEP_t)$

C. RATE MAKING

(A2.24) $RB_t = NPIS_t + CAFDC_t - ADEFTAX_t - DEFTAX_t$

(A2.25) $WACC_t = \frac{EQ_t}{EQ + \sum D_t} * AROE + \sum \frac{D_t}{ED_t + \sum} * C_i$

(A2.26) $AFDCRAT_t = \frac{EQ_t}{EQ + \sum D_t} * AROE + (1-\tau \frac{D_t}{ED_t + \sum} * C_i$

(A2.27) $APROFIT_t = RB_t * WACC_t$

(A2.28) $ATAXES_t^{EQ} = \frac{\tau}{1-\tau} * \frac{EQ_t}{EQ + \sum D_i} * RB_t * AROE$

(A2.29) $ATAXES_t^0 \quad \frac{\tau}{1-\tau} [AMABN_t + BKAMORT_t - ANITC_t]$

(A2.30) $ATAXES_t = ATAXES_t - EQ + ATAXES_t - 0$

(A2.31) $AREV_t = APROFIT_t + ATAXES_t - ANITC_t + BKDEP_t + BKAMORT_t + OM_t + AMABN_t$

D. COMPUTE ACTUAL NET INCOME

1. Income Statement

(A2.32) $REV_t = AREV_t$

(A2.33) $INT_t = \sum_i D_t * C_i$

(A2.34) $EBT_t = REV_t - OM_t + AMNITC_t - BKDEP_t - BKAMORT_t - AMABN_t - INT_t$

2. Tax Calculations

(A2.35) $TAXINC_t = REV_t - OM_t - TAXDEP_t - INT_t$

(A2.36) $TXLIAB_t = \tau \; TAXINC_t$

(A2.37) $CITAX_t = TAXLIAB_t - NITC_t - DEFTABN_t$

(A2.38) $RAFDC_t = AFDCRAT_t * (CWIP_t + AAFDC_t + WC_t$

(A2.39) $NI_t = EBT_t - CITAX_t - DEFTAX_t - NITC_t - DEFTABN_t + RAFDC_t$

E. UPDATE END OF YEAR BALANCE SHEET

1. Assets

(A2.40) $NPIS_t = NPIS_t - BKDEP_t$

(A2.41) $CAFCC_t = CAFDC_t + RAFDC_t - BKAMORT_t$

(A2.42) $WC_t = WC_t - AAFDC_t$

(A2.43) $UP_t = NPIS_t + CAFDC_t + CWIP_t \; AAFDC_t + WC_t$

(A2.44) $ABN_t = ABN_t - DEFTABN_t - AMABN_t$

(A2.45) $ASSETS_t = UP_t + ABN_t$

2. Liabilities

(A2.46) $ANITC_t = ANITC_t + NITC_t - AMNITC_t$

(A2.47) $ADEFTAX_t = ADEFTAC_t + DEFTAX_t$

(A2.48) $TDL_t = ANITC_t + ADEFTAX_t$

(A2.49) $TPC_t = ASSEST_t - TDL_t$

(A2.50) $D_t = (1-EQSHAR\ ) * TPC_t$

(A2.51) $EQ_t = EQSHAR * TPC_t$

F. DETERMINING CASH FLOWS

1. Sources of Funds

(A2.52) $ISOURC_t = NI_t + BKDEP_t + BKAMORT_t - AMNITC_t + NITC_t + DEFTAX_t + AMABN_t + DEFTABN_t - RAFDC_t$

(A2.53) $ESOURC_t = NUEQ_t + NUD_t$

(A2.54) $TSOURC_t = ISOURC_t + ESOURC_t$

2. Uses of Funds

(A2.55) $NUPLANT_t = (UP_t - WC_t) - (UP_{t-1} - WC_{t-1})$

(A2.56) $\Delta WC_t = WC_t - WC_{t-1}$

(A2.57) $DIV_t = NI_t$

(A2.58) $RFD_t = D_t - D_{t-1}$

(A2.59) $RFEQ_t = EQ_t - EQ_{t-1}$

(A2.60) $TUSES_t = NUPLANT_t - RAFDC_t + \Delta WC_t + DIV_t + RFD_t + RFEQ_t$

APPENDIX 3 DESCRIPTION OF SIMULATION OUTPUT

In our example, a utility builds a facility over a two year period, and operates the facility for seven years. Exogenous to the model, a financing plan has been established to raise $600 at the beginning of the first and second year. A sudden shift in interest rates takes place between year 1 and year 2 so the coupon rate on the bonds shifts from 5% to 10%. This yields an imbedded cost of debt of 7.5%. The allowed rate of return on equity remains 15% through the model. Tax depreciation is computed by the sum of years digits (SOYD) method over a seven year lifetime, based on original cost excluding an allowance for funds used during construction. Upon completion, the original cost less AFDC is eligible for a 10% investment tax credit. Federal corporate income tax is computed on a marginal rate equal to the average rate of 50%. Lastly, the O&M expenses are supplied exogenously. All of this information is summarizesd in table A3.1. An alphabetized list of all the variables used on the financial tables is located in appendix 2.

The simulation starts with the utility's balance sheet in table A3.2. To make the underlying transactions more transparent, the first three years are represented twice, with a beginning of year (BOY) and end of year (EOY) statement. After year 3, $BOY_t = EOY_{t-1}$ on the

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*With only one faciltiy, the rationale for this is obvious, since the utility has nothing to sell. However, most utilities have many facilities and could have their rates increased.

Table A3.1

Exogenous Time Series

year	1	2	3	5	5	6	7	8	9
$ABNCWIP_t$	0	0	100	0	0	0	0	0	0
$ABNAFDC_t$	0	0	11.3	0	0	0	0	0	0
$BKPLANT_t$	0	0	1000	0	0	0	0	0	0
$NUCON_t$	400	600	0	0	0	0	0	0	0
NC_t	600	600	0	0	0	0	0	0	0
OM_t	0	0	500	550	600	650	700	750	800

Parameters

BKLIFE	7	Book Life of Plant
TXLIFE	7	(SOYD) Tax Life of Plant
ITCLIFE	7	ITC Amortization Lifetime
ITCRATE	10%	ITC Rate
EQSHAR	25%	Equity Share of New Capital
AROE	15%	Cost of Equity
τ	50%	Tax Rate
c_1	5%	Coupon rate on first series debt
c_2	10%	Coupon rate of second series debt

Table A3.2

UTILITY BALANCE SHEET

		Year 1		Year 2		Year 3							
	EOY 0	BOY 1	EOY 1	BOY2	EOY2	BOY 3	EOY 3	EOY4	EOY 5	EOY 6	EOY 7	EOY 8	EOY 9
ASSETS													
NPIS	0	0	0	0	0	900.00	771.43	642.85	514.29	385.72	257.15	128.58	0
CAFDC	0	0	0	0	0	101.25	86.79	72.33	57.87	43/41	28.95	14.49	0
CWIP	0	400	400	1000	1000	0	0	0	0	0	0	0	0
AAFDC	0	033.75	33.75	112.50	0	0	0	0	0	0	0	0	0
WC	0	200	166.25	166.25	0	0	0	0	0	0	0	0	0
UP	0	600	600	1200.00	1112.50	1001.25	858.22	715.19	572.16	429.13	286.10	143.07	0
ABN	0	0	0.00	0	0	111.25	49.00	36.75	24.50	12.25	0	0	0
ASSETS	0	600	600	1200.00	1112.50	1112.50	907.22	751.94	596.66	441.38	286.10	143.07	0
LIABILITIES													
D	0	450	450	900	834.38	834.38	586.40	455.48	336.61	229.79	135.03	61.51	0.00
EQ	0	150	150	300	278.12	278.12	195.46	151.82	112.20	76.60	45.01	20.50	0.00
TPC	0	600	600	120	1112.50	1112.50	781.86	607.30	448.81	306.39	180.04	82.01	0.00
ANITC	0	0	0	0	0	0	77.14	64.28	51.42	38.56	25.70	12.84	0.00
ADEFTAX	0	0	0	0	0	0	48.22	80.36	96.43	96.43	80.36	48.22	0.00
TDL	0	0	0	0	0	0	125.36	144.64	147.85	134.99	106.06	61.06	
LIABS	0	0	600	1200	1112.50	1112.50	907.22	751.94	596.66	441.38	286.10	143.07	0.00

balance sheet.

At BOY1, the utility raises cash and invests it in CWIP and working capital (WC). During periods of construction the firm needsto keep cash on hand to pay its bills. Since the plant is not used and useful, the utility is not allowed to collect any revenues from customers.* This is the AFDC method. The utility is allowed to capitalize foregone earnings and later earn a rate of return on them and amortize these capitalized earnings through increased allowed revenues over the lifetime of the plant. Thus, table A3.3 shows an allowed revenue of $0 under ratemaking, whereas table A3.4, the income statement, shows a net income of $22.50, which equals a 15% return on the $150 of paid in equity capital. This seeming anomaly is explained by table 4.5, the statement of sources and uses of funds for EOY1 which shows that the firm did not generate any cash from operations. In fact, it had a negative cash flow.

The Sources and Uses statement contains the information needed to compute net cash flows. The net cash flow to shareholders is the sum of dividend payments and returns of equity capital. To distinguish between cash flows that occur at the beginning and end of the year, the sources and uses statement is also divided into BOY and EOY for the first three years. Since the only cash transaction that occurs in the beginning of the year is raising new external funds, there are no BOY cash flows after year 2. To determine dividends and return of capital, the rate making process must be traced out.

At the beginning of year 3, part of the construction expenditures and accumulated AFDC during construction(AAFDC) are entered into the net plant in service(NPIS) and the capitalized AFDC (CAFDC) account, while the remainder is abandoned. The booked plant is the rate base for rate making. Multiplying the rate base by HWACC yields an allowed profit, APROFIT. An allowance for taxes, ATAXES^{EQ} must be included to cover expected Federal corporate tax liabilities. A further adjustment, ATAXES^{0} must be made to allow for the non-deductibility for taxes of amortized AFDC, (BKAMORT), amortized abandonment, (AMABN), and the lack of income recognition of amortized ITC, (AMNITC). Since the shareholder is interested in after tax income, summing up all of these non-cash transactions is required.

The income statement in year 3 is now based on positive revenues. The derivation of earnings before taxes, EBT, is straightforward, except that the interest charge is the actual interest payable on outstanding debt, not the allowed interest. The Federal tax computations are done on table A3.6. Taxable income times the tax rate yields the tax liability. However, in year 3, ITC and the tax shield arising from abandoning a portion of the construction are in excess of the tax liability. Thus, the firm actually receives a substantial tax refund. In actual practice, the Federal Government does not usually make negative income tax payments. However, in a large firm, the excess tax losses generated in one division can be used to offset taxable income in other divisions. In that sense, this is not an unreasonable way of treating taxes for a single project. Lastly, deferred taxes from accelerated depreciation are charged off against earnings to provide for a levelized net income.

The actual net income in period 3 is \$34.41. This is less than \$37.55= .15 * .25 * 1001.25, the equity return allowed for in rate making. Table A3.7 provides a reconciliation of this discrepency, as was discussed previously.

Given the write downs of NPIS, CAFDC, and abandonments (ABN), the amount of the firm's assets in the next year can be determined. Similarly, given the amortization of ITC and the change in the level in deferred taxes, the amount of total differed liabilities (TDL) are determined. Subtracting,

$$TPC_t = ASSETS_t - TDL_t$$

$$EQ_t = EQSHAR * TPC_t$$

$$D_t = (1-EQSHAR) * TPC_t,$$

the desired level of each kind of proprietary capital can be determined. Comparing this with the level of debt and equity at the beginning of the year, the amount of capital refunding is computed.

The bottom of table A3.5 has the net cash flows to equity. Taking the net present value of these cash flows, the firms equity has a slightly negative value at the outset of the project. This should not be startling since they had to abandon a substantial amount of plant. If it were not for the favorable regulatory treatment of ITC, the NPV would be even lower.

Table A3.3

RATE MAKING

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
HWACC	.075000	.093750	.093750	.093750	.093750	.093750	.093750	.093750	.093750
AFDCRAT	.056250	.065625	-	-	-	-	-	-	-
UP(-1)	0	0	1001.25	858.22	715.19	572.16	429.13	286.10	143.07
ADEFTAX	0	0	0.00	48.22	80.36	96.43	96.43	80.36	48.22
RB	-	-	1001.25	810.00	634.83	475.73	332.70	105.74	94.85
APROFIT	0	0	93.87	75.94	59.52	44.60	31.19	19.29	8.89
ATAXES-EQ	0	0	37.55	30.38	23.81	17.84	12.48	7.72	3.56
ATAXES-D	0	0	13.85	13.85	13.85	13.85	13.85	1.60	1.65
BKDEP	0	0	128.57	128.57	128.57	128.58	128.57	128.57	128.58
BKAMORT	0	0	14.46	14.46	14.46	14.46	14.46	14.46	14.49
AMNITC	0	0	(12.86)	(12.86)	(12.86)	(12.86)	(12.86)	(12.86)	(12.84)
AMABN	0	0	12.25	12.25	12.25	12.25	12.25	0.00	0.00
OM	0	0	500.00	550.00	600.00	650.00	700.00	750.00	800.00
AREV	0	0	787.69	812.59	839.60	868.71	899,94	908.78	944.33

Table A3.4

INCOME STATEMENT

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
REV	0	0	787.69	812.59	839.60	868.71	899.94	908.78	944.33
Less:OM	0	0	500.00	550.00	600.00	650.00	700.00	750.00	800.00
BKDEP	0	0	126.57	128.57	128.57	128.58	128.57	128.57	128.58
BKAMORT	0	0	(12.86)	(12.86)	(12.86)	(12.86)	(12.86)	(12.86)	(12.84)
AMABN	0	0	12.25	12.25	12.25	12.25	12.25	0.00	0.00
INT	22.50	67.50	62.58	43.98	34.16	25.25	17.23	10.13	4.61
EBT	-22.50	-67.50	82.69	76.19	63.02	51.04	40.29	18.48	9.49
Less:CITX	-11.25	-33.75	139.94	12.88	22.37	32.45	43.14	42.18	53.79
NITC	0.00	0.00	(90.00)	0.00	0.00	0.00	0.00	0.00	0.00
DEFTAX	0.00	0.00	48.22	32.14	16.07	0.00	-16.07	-32.14	-48.22
RAFDC	33.75	78.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NI	22.50	45.00	34.41	31.17	24.59	18.59	13.22	8.44	3.92

Table A3.5

COMPUTATION OF CASH FEDERAL INCOME TAX PAYMENT OR REFUND

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
REV	0	0	787.69	812.59	839.60	868.71	899.94	908.78	944.33
Less:OM	0	0	500.00	550.00	600.00	650.00	700.00	750.00	800.00
TAXDEP	0	0	225.00	192.86	160.71	128.57	96.43	64.29	32.14
INT	22.50	67.50	62.58	43.98	34.16	25.25	17.23	10.13	4.61
EBT	-22.50	-67.50	82.69	76.19	63.02	51.04	40.29	18.48	9.49
TAXLIAB	-11.25	-33.75	139.94	12.88	22.37	32.45	43.14	42.18	53.79
LESS:NITC	0.00	0.00	90.00	0.00	0.00	0.00	0.00	0.00	0.00
DEFTABN	0.00	0.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00
CITAX	-11.25	-33.75	-139.94	12.88	22.37	32.45	43.14	42.18	53.79

Table A3.6

STATEMENT OF SOURCES AND USES OF FUNDS

	Year 1		Year 2		Year 3							
	BOY 1	EOY 1	BOY2	EOY2	BOY 3	EOY 3	EOY4	EOY 5	EOY 6	EOY 7	EOY 8	EOY 9
SOURCES												
NI	0	22.50	0	45.00	0	34.41	31.17	24.59	18.59	13.22	8.44	3.92
BKDEP	0	0	0	0	0	128.57	128.57	128.57	128.57	128.57	128.57	128.58
BKAMORT	0	0	0	0	0	14.46	14.46	14.46	14.46	14.46	14.46	14.49
ANITC	(0)	(0)	(0)	(0)	(0)	(12.86)	(12.86)	(12.86)	(12.86)	(12.86)	(12.86)	(12.84)
NITC	0	0	0	0	0	90.00	0	0	0	0	0	0
DEFTAX	0	0	0	0	0	48.22	32.14	16.07	0.00	-16.07	034.12	-48.22
AMABN	0	0	0	0	0	12.25	12.25	12.25	12.25	12.25	0	0
DEFTABN	0	0	0	0	0	50.00	0	0	0	0	0	0
RAFDC	(0)	(33.75)	0	(33.75)	0	0	0	0	0	0	0	0
ISOURC	0	(11.25)	0	(33.75)	0	365.05	205.73	183.08	161.01	139.57	106.47	85.93
NUO	450	0	450	0	0	0	0	0	0	0	0	0
NUEQ	150	0	150	0	0	0	0	0	0	0	0	0
ESOURC	600	0	600	0	0	0	0	0	0	0	0	0
TSOURC	600	(11.25)	600	(33.75)	0	365.05	205.73	170.83	161.01	139.57	106.47	85.93
USES												
NUPLANT	400	0	633.75	78,75	0	0	0	0	0	0	0	0
RAFDC	(0)	(0)	(33.75	78.75)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
ΔWC	200	(33.75	0	(166.25)	0	0	0	0	0	0	0	0
DIV	0	22.50	0	45.00	0	34.41	31.17	24.59	18.59	13.22	8.44	3.92
RefundD	0	0	0	65.63	0	248.98	130.92	118.87	106.82	94.76	73.52	61.51
RefundEQ	0	0	0	21.87	0	82.66	43.64	39.62	35.60	31.59	24.51	20.50
TUSES	600	(11.25)	600	(33.75)	0	365.05	205.73	183.08	161.01	139.57	106.47	85.93
NCF*(EQ)	-150.00	22.50	-150.00	66.87	0	117.07	74.81	64.21	54.19	44.81	32.95	24.42

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*For discounting purposes, the cash flows of EOY_t and BOY_{t+1} can be treated as occurring simultaneously at EOY_t

Table A3.7

RECONCILIATION OF ALLOWED RETURN ON EQUITY AND NET INCOME

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
EQUITY RETURN	0	0	37.55	30.38	23.81	17.84	12.48	7.72	3.56
RAFDC-INT	22.50	67.50	0	0	0	0	0	0	0
Less:INT or ABN	0	0	6.26	2.76	2.07	1.38	0.69	0.00	0.00
Plus:TSINT ABN	0	0	3.13	1.38	1.03	.69	0.34	0.00	0.00
Plus:INT or NITC	0	0	0	4.34	3.62	2.89	2.17	1.45	0.72
Less:TSINT NITC	0	0	0	2.17	1.81	1.45	1.08	0.72	0.36
Expected NI	22.50	45.00	34.42	31.17	24.59	18.60	13.22	8.44	3.92
NI	22.50	22.50	34.41	31.17	24.59	18.59	13.22	8.44	3.92
Discrepancy	0.00	0.00	0.01	0.00	0.00	-0.01	0.00	0.00	0.00

APPENDIX 4 IMPLICIT RENT CALCULATION TABLES

Table A4.1 COMPUTATION OF PRESENT VALUE OF MARKET RATES OF RETURN ON THE RATE BASE

TABLE A4.2 PRESENT VALUE OF AMORTIZATION OF ITC

TABLE A4.3 PRESENT VALUE OF DEBT OF DEREGULATED FIRM

Table A4.1

PRESENT VALUE OF MARKET RATES OF RETURN ON THE RATE BASE

			Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
i^r			.100	.100	.100	.100	.100	.100
HIRR			.075	.075	.075	.075	.075	.075
i^r-HIRR			.025	.025	.025	.025	.025	.025
RB			810.00	634.83	475.73	332.70	205.74	94.85
D_{RB}			607.50	476.12	356.80	249.53	154.31	71.14
i^r-HIRR)*D_{RB}			15.19	11.90	8.92	6.24	3.86	1.78
$PV_R(\Delta D)$	Scenario 2	37.92						
	Scenario 3	36.00						
r^r			.175	.175	.175	.175	.175	.175
AROE			.150	.150	.150	.150	.150	.150
r^r-AROE			.025	.025	.025	.025	.025	.025
EQ_{RB}			202.50	158.71	118.93	83.18	51.44	23.71
$(r^r - AROE)*EQ_{RB}$			5.06	3.97	2.97	2.08	1.29	0.59
$PV^R(\Delta EQ)$	Scenario 2	10.90						
	Scenario 3	10.41						

Table A4.2
Present Value of Amortization of ITC

			Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
			12.86	12.86	12.86	12.86	12.86	12.84
NPV	Scenario 1a, 1b	67.95						
NPV	Scenario 2	65.26						
NPV	Scenario 3	62.73						

Table A4.3

PRESENT VALUE OF DEBT OF DEREGULATED FIRM

			EOY 4	EOY 5	EOY 6	EOY 7	EOY 8	EOY 9
INT			43.98	34.16	25.25	17.23	10.13	4.51
Refund D			130.92	118.87	106.82	94.76	73.52	61.51
			174.90	153.03	132.07	111.99	83.65	66.02
$PV^D(D)$	Scenario 1a,1b	586.40						
$PV^D(D)$	Scenario 2	550.39						
$PV^D(D)$	Scenario 3	518.04						
$PV^R(D)$	Scenario 1a,1b	586.40						
$PV^R(D)$	Scenario 2	550.39						
$PV^R(D)$	Scenario 3	550.30						

APPENDIX 5 Derivation of Regulatory Allowance for Taxes

(A5.1) $$AREV = APROFIT + ATAXES + OM + BKDEP - ANITC + BKAMORT + AMABN$$

(A5.2) $$REV - OM + ANITC - TAX - INT - BKAMORT - BKDEP - DEFTAX - AMABN = NI$$

(A5.3) $$TAX = \tau(REV - OM - TXDEP - OM - INT)$$

If APROFIT = INT + EQRET, then the goal is

(A5.4) $$NI = EQRET = AROE * E/D+E * RB$$

We assume that

(A5.5) $$AREV = REV$$

Rearranging (A5.2) and substituting (A5.3)

$$REV = 1/1-\tau\ [-ANTIC + BKAMORT + AMABN + NI] + OM + INT + BKDEP$$

Substituting into both sides of (A5.5)

$$ATAXES = (\tau/(1-\tau))\ [-ANITC + BKAMORT + AMABN + AROE * E/D+E * RB]$$

Split the allowance into two components, the allowance due to a return on the utility's equity, and taxes which arise because of differences between regulatory and tax accounting.

$$ATAXES^{EQ} = (\tau/(1-\tau)) * AROE * E/D+E * RB$$

$$ATAXES^{0} = (\tau/(1-\tau)) * [-ANITC + BKAMORT + AMABN]$$

$$ATAXES = ATAXES^{0} + ATAXES^{EQ}$$

APPENDIX 6 AGGREGATE NATIONAL IMPLICIT REGULATORY RENT CALCULATION TABLES

Table A6.1 PRESENT VALUE OF OUTSTANDING UTILITY BONDS

Table A6.2 FLOW-THROUGH UTILITIES IN TOP 100

Table A6.3 1980 AFTER-TAX COST OF CAPITAL

Table A6.4 REPLACEMENT COSTS OF ELECTRIC UTILITY ASSETS

Table A6.5 NOMINAL COST OF ELECTRIC UTILITY ASSETS

Table A6.1

PRESENT VALUE OF OUTSTANDING UTILITY BONDS

Year	Refunding Schedule	Truncate after '10	1979&1980 New Debt	Total Refunding	Interest @ t-30	Net Present Val.
1981	1,852			1,852	3.25	1,685
1982	2,569			2,569	3.36	2,139
1983	1,952			1,952	3.75	1,508
1984	2,040			2,040	3.11	1,418
1985	1,578			1,578	3.30	1,020
1986	1,080			1,080	3.86	671
1987	2,339			2,339	4.80	1,456
1988	1,371			1,371	4.18	770
1989	879			879	4.92	500
1990	1,338			1,338	4.72	715
1991	1,151			1,151	4.72	590
1992	1,303			1,303	4.40	619
1993	1,543			1,543	4.40	706
1994	1,840			1,840	4.55	830
1995	1,424			1,424	4.61	629
1996	3,060			3,060	5.53	1,496
1997	2,820			2,820	6.07	1,453
1998	3,119			3,119	6.80	1,735
1999	3,147			3,147	7.98	1,982
2000	4,061			4,061	8.76	2,756
2001	4,733			4,733	7.71	2,854
2002	4,741			4,741	7.50	2,772
2003	4,659			4,659	7.91	2,843
2004	4,366			4,366	9.59	3,171
2005	3,706			3,706	9.97	2,786
2006	5,745			5,745	8.92	3,880
2007	5,369			5,369	8.43	3,429
2008	202			202	9.30	141
2009	421		9,403	9,824	10.85	7,968
2010	112	229	11,164	11,505	13.46	11,505
TOTAL	75,987	229	20,567	96,783		66,027

Sources: "Schedule of Electric Utility Debt Falling Due 1978-2037." Statistics of Privately Owned Electric Utilities in the United States 1977. p.10

"Weighted Average Yields on Newly Issued Domestic Bonds and Preferred Stock". Statistical Year Book of the Electric Utility Industry. (many issues).

Table A6.2

FLOW-THROUGH UTILITIES IN THE TOP 100

	Accumulated Deferred Taxes (December 31, 1980)
Pacific Gas & Electric	25,701,778
Consolidated Edison of NY	317,079,865
Southern California Edison	28,292,535
Niagara Mohawk Power	94,181,000
Northeast Utilities	
Connecticut Light	27,236,397
Hartford Electric	13,380,832
Long Island Lighting	25,014,439
Union Electric	168,203,000
Pacific Power & Light	6,338,279
San Diego Gas & Electric	30,168,388
Arizona Public Service	12,985,544
New York State Electric & Gas	34,023,487
Rochester Gas & Electric	30,281,712
Portland General Electric	37,673,422
Orange & Rockland Utilities	35,382,862
United Illuminating	7,207,735
Central Maine Power	34,992,369
Central Hudson Gas & Electric	21,892,616
Tucson Electric Power	3,121,964
Nevada Power	937,740
Central Vermont Public Service	9,294,929
TOTAL	963,390,893

Sources: Data on flow-through vs. normalized in the top 100.
"Seventh Annual Survey of the 100 Largest Utility Companies."
Data on accumulated deferred taxes.
Statistics of Privately Owned Utilities in the United States 1980.

Table A6.3

1980 AFTER-TAX COST OF CAPITAL

Market value capitalization ratios are computed to determine a weighted average cost of capital of the industry.

	Book Value	Price/ Book	Market Value	% Capital	Market Rates
Debt	105,257	0.68	66,027	47.2	13.46
Prefered	25,440	0.57	14,501	10.4	13.91
Common	79,043	0.75	59,282	42.4	17.00
TOTAL			139,810	100.0	

$$\text{ATCOC} = D/(D+P+E) * i * (1-t) + P/(D+P+E) * d + E/(D+P+E) * r$$

$$= 0.0917$$

Sources: see section 6.
The cost of equity is an educated guess. No definitive data is available on this.

Table A6.4

REPLACEMENT COST OF ELECTRIC UTILITY ASSETS

(Billions of Dollars)

Year	Investment	STL % Remaining	Left on Books	Replacement Index	Replacement Value
1980	26,044	.967	25,185	1.06	26,696
1979	24,378	.933	22,745	1.15	26,156
1978	22,393	.900	20,154	1.27	25,595
1977	19,758	.867	17,130	1.33	22,783
1976	16,979	.833	14,144	1.43	20,225
1975	15,090	.800	12,072	1.51	18,229
1974	16,350	.767	12,540	1.77	22,197
1973	14,907	.733	10,927	2.14	23,383
1972	13,385	.700	9,370	2.27	21,269
1971	11,894	.667	7,933	2.39	18,961
1970	10,145	.633	6,422	2.58	16,568
1969	8,294	.600	4,976	2.79	13,884
1968	7,140	.567	4,048	2.97	12,024
1967	6,120	.533	3,262	3.06	9,982
1966	4,932	.500	2,466	3.18	7,842
1965	4,027	.467	1,881	3.27	6,150
1964	3,551	.433	1,538	3.37	5,182
1963	3,319	.400	1,328	3.48	4,620
1962	3,154	.376	1,158	3.46	4,005
1961	3,256	.333	1,084	3.50	3,795
1960	3,331	.300	999	3.41	3,408
1959	3,383	.267	903	3.41	3,080
1958	3,764	.233	877	3.50	3,070
1957	3,679	.200	736	3.59	2,642
1956	2,910	.167	486	3.81	1,852
1955	2,719	.133	362	4.19	1,515
1954	2,835	.100	284	4.29	1,216
1953	2,876	.067	193	4.35	838
1952	2,599	.033	86	4.61	395
TOTAL	263,212				327,562

Sources: Investment data. Statistical Year Book of the Electric Utility Industry. (many years).

Handy-Whitman Index. Statistical Year Book of the Electric Utility Industry. (many years). The index was converted completely into 1949 = 100. Replacement index was Mean HW Index(Jan. 1, 1981)/Mean HW Index of July 1 of the Year of Investment.

Table A6.5

NOMINAL COST OF ELECTRIC UTILITY ASSETS

(Billions of Dollars)

Year	Investment	STL % Remaining	Left on Books	Inflation Index	1980 $ Value
1980	26,044	.967	25,185	1.01	25,437
1979	24,378	.933	22,745	1.10	25,020
1978	22,393	.900	20,154	1.19	23,983
1977	19,758	.867	17,130	1.28	21,926
1976	16,979	.833	14,144	1.36	19,236
1975	15,090	.800	12,072	1.43	17,263
1974	16,350	.767	12,540	1.56	19,562
1973	14,907	.733	10,927	1.70	18,576
1972	13,385	.700	9,370	1.79	16,772
1971	11,894	.667	7,933	1.87	14,835
1970	10,145	.633	6,422	1.97	12,651
1969	8,294	.600	4,976	2.06	10,251
1968	7,140	.567	4,048	2.17	8,7344
1967	6,120	.533	3,262	2.27	7,405
1966	4,932	.500	2,466	2.33	5,746
1965	4,027	.467	1,881	2.41	4,533
1964	3,551	.433	1,538	2.46	3,783
1963	3,319	.400	1,328	2.50	3,320
1962	3,154	.376	1,158	2.54	2,941
1961	3,256	.333	1,084	2.58	2,797
1960	3,331	.300	999	2.61	2,607
1959	3,383	.267	903	2.65	2,393
1958	3,764	.233	877	2.71	2,377
1957	3,679	.200	736	2.76	2,031
1956	2,910	.167	486	2.85	1,385
1955	2,719	.133	362	2.95	1,068
1954	2,835	.100	284	3.01	855
1953	2,876	.067	193	3.05	589
1952	2,599	.033	86	3.09	266
TOTAL	263,212				241,893

Sources: Investment data. Statistical Year Book of the Electric Utility Industry. (many years).

Inflation Index. Economic Report of the President, 1980. Inflation index was GNP Deflator(1980 III)/GNP Deflator of the Year of Investment.

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